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STATISTICS

OF

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MINES AND MINING

IN THE STATES AND TERRITORIES

WEST OF THE ROCKY MOUNTAINS;

BEING

THE SIXTH ANNUAL REPORT

OF

ROSSITER W. RAYMOND,
UNITED STATES COMMISSIONER OF MINING STATISTICS.

WASHINGTON:
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INTRODUCTORY.

WASHINGTON, *February* 18, 1874.

SIR: I have the honor to transmit herewith my report on mines and mining in the States and Territories, California, Nevada, Idaho, Montana, Oregon, Utah, Colorado, New Mexico, Arizona, and Alaska, together with such observations, comparisons, and suggestions as may serve to indicate the condition of the arts of mining and metallurgy in that portion of the country, and also to contribute to the progress and improvement of those arts. Some criticisms are also offered with respect to the general mining law.

This report is the sixth I have had the honor to prepare for the Government. Including the two reports of Hon. J. Ross Browne, my predecessor, the series on mining statistics now comprises eight volumes, and I deem it not uninteresting or out of place to briefly review, on this occasion, the work which has been performed in the preparation of these volumes, and the nature of the contributions which they have made to the progress of the mining industry.

Mr. Browne's reports, having to deal with an entirely new and almost untrodden field, were naturally occupied with the rough survey of the resources and industry of the vast area described. No special place could be given so early in the work to discussions or suggestions calculated to increase the economy and productiveness of this industry by disseminating correct views and means of comparison among the mining communities.

Upon assuming the position of Commissioner, I was impressed with the importance of such a feature in future reports; and accordingly I adopted, at the outset, a plan which I have since continued through six volumes, dividing each report into sections or parts, one of which was devoted to the condition of the mining industry, comprising the description of new or previously undescribed districts, and of new discoveries and current progress in old districts. In this part of the report much pains have been taken to avoid unnecessary repetition; hence every report contains numerous references to foregoing ones, and the whole series presents a reasonably complete exhibit of the mining districts of the West, the nature of their mineral deposits, and the progress of their development.

The other parts of my annual report have been devoted to the presentation of such valuable information as my own professional knowledge and labors, together with the co-operation of numerous public-spirited citizens and of my assistants, correspondents, and professional colleagues could furnish. It will be seen by review of the successive volumes that different topics have been brought forward, from time to time, in the order, not so much of their technical relations to each other, as of their special timeliness or importance to the country in each year.

Thus, in my first report, rendered in 1869, I discussed at length the relations of governments to mining, particularly with respect to the two great departments of mining law and mining education. The principles thus laid down have been, I venture to believe, not without influence upon the legislation of later years, and upon the remarkable development of schools for instruction in mining and metallurgy which those years have witnessed. These topics have been alluded to in subsequent reports as occasion has seemed to require.

In my second annual report, rendered in 1870, I presented, after the usual review of the mining districts, a treatise on mineral deposits calculated to expose and refute numerous popular errors upon the subject which have seriously interfered with rational mining. In the same volume was given an extensive treatise on the mechanical appliances of mining which has become widely known, and has been published in a separate edition. Under the head of "Metallurgical Processes" I described, in the same year, two important novelties, the Stetefeldt furnace and the Brückner cylinder, and initiated a discussion concerning the proper construction of stamp batteries, and the speed and weight of stamps, which has borne fruit in marked improvement throughout the country.

In my third annual report, rendered in 1871, the stamp-mill process of Colorado was thoroughly discussed, and suggestions of improvement were made which practice has since demonstrated to have been judicious. The essay on the Washoe process, by Professor Hague, first published in the third volume of the Report of the Exploration of the Fortieth Parallel, was republished, for wider popular circulation, in this volume of my reports, with numerous annotations of my own. The subject of chlorination was also discussed, and the extensive, complicated, and difficult topic of smelting silver ores was entered upon.

The smelting industry of the West having increased with marked rapidity, I devoted a large part of my fourth annual report to subjects connected with it, giving details of practice and drawings of apparatus, and at the same time describing an important variation of the Washoe process, by means of which rebellious ores could be treated without roasting, by amalgamation in pans, with the aid of chemicals. Descriptions of practice in Mexico and South America were also introduced for purposes of comparison.

The rapid consumption of charcoal, occasioned by the new industry in all the western districts, brought into prominence a most important question, namely, that of the metallurgical value of the lignites of the Rocky Mountains, and to this point much attention was given, and much practical information was collected and made public through my reports of 1872 and 1873.

In my fifth annual report, rendered in 1873, the stamp-mill process, as it exists in California in its greatest perfection, was thoroughly described, with working-drawings so complete as to be suitable for use by the miners of less favored districts. In the same volume the important subjects of economy in smelting and of the calorific value of the western lignites received further treatment. A new topic was introduced by the thorough description, never before given, I believe, with such fullness and accuracy, of the American process of hydraulic mining, to which account a discussion of the Pliocene rivers of California, the sources of hydraulic deposits, constituted an appropriate introduction. This report contained also a chapter on the dressing of ores, a subject which every year brings into greater prominence in this country, as the amount of tailings and low-grade ores, accumulated in our mining districts, grows larger, and the truth impresses itself more clearly upon our mining communities that the successful treatment of these classes of material is the only permanent basis for an extensive mining industry. The report of 1873 contained, also, numerous drawings of mining machinery, intended to illustrate the latest patterns which experience has led the manufactories of the Pacific coast to adopt. It was, moreover, accompanied with a copy of an excellent geological map of the United States, universally acknowledged to be the most convenient and trustworthy yet published.

It should be added, as a feature of no small importance to the usefulness of these volumes, that each one of them is provided with a triple alphabetical index of mines, mining districts, and subjects, so that the information they contain can be instantaneously referred to when it is needed.

In accordance with the plan I have described, the report which I now have the honor to present contains the usual survey of the condition of mining industry in the several States and Territories, and, following this, a series of chapters upon subjects of vital importance to this industry in its present stage. The chapter on the mining and metallurgy of quicksilver treats of a topic which has never before been discussed at length in these reports, though its importance would have justified its introduction at any time. At the present time, however, it is more than usually interesting to the miners of California, since the falling off in the quicksilver production of the leading mines has led to extraordinary activity in the exploration and development of our numerous quicksilver deposits.

The immensely important subject of smelting receives, in the present volume, fresh and extensive treatment. It has been my purpose to collect, so far as practicable, the records of American practice, and to place them side by side with the working results of the best foreign establishments. This object has been, in the present and two preceding reports, measurably accomplished; and, I believe, the result will be a great improvement in the direction of economy and productiveness at American metallurgical works, and, consequently, a great saving to the country, as well as to individual owners, of wealth which is now, by carelessness or ignorance, irreparably wasted.

The only important contribution to mine-engineering, described in the present volume, is found in the chapter on sinking shafts with the diamond drill. This method, which owes its origin to American skill and ingenuity, has attracted much attention at home and abroad, and I am glad to be able to place upon record so clear and complete an account of it.

There are many important branches of mining and metallurgical practice which have not yet been discussed in this series of reports. It has not been my object to produce a connected and comprehensive manual of these arts, though the material thus gradually accumulated by annual installments constitutes a very respectable beginning toward such a manual; but I have sought to treat such subjects only as were immediately important to our own people, and had a direct bearing upon the economy and productiveness of the mines on the public domain. Hence many leading departments of mine-engineering have been little noticed, some of which, by the rapid increase in extent and depth of American mines, are now acquiring prominent importance. I may mention as examples the subjects of timbering, ventilation, drainage, &c., on all of which information is sadly needed in many parts of the West.

It will be noticed that several chapters in the present report have been presented as papers before the American Institute of Mining Engineers. This society has been in existence but three years, and has already acquired a large membership, comprising the leading mining and metallurgical engineers of this country, together with numerous foreign members of distinction. Having had the honor to be its president since May, 1872, I have made use of that official position, I trust not unwarrantably, in urging members of the Institute, connected with metallurgical establishments in this country, to choose for their contributions to the Institute subjects suitable for publication in my reports to the Government, as presenting much needed accurate information concerning the details of American practice. The Government has thus received, without cost, an amount of valuable statistical and scientific information which scarcely could have been obtained in any other way; and the public spirit and professional enthusiasm of the members of this young and remarkably successful society deserve the highest praise.

The progress of the mining industry in the Pacific States and Territories, during the year 1873, was, in general, satisfactory. As will be seen by the estimates contained in the last chapter of this report, the total production was much larger than in 1872. The increase was, however, confined to the State of Nevada and the Territory of Utah.

California has slightly declined in production. Other parts of the West may be said to have barely maintained their former rates. The extraordinary production of Nevada is referable to the Comstock mines, and the great deposits of smelting-ore in Eureka County. Detailed information concerning these and all other districts can be found in the respective chapters of the report.

Credit is given, throughout this report, to the numerous gentlemen who have assisted in its preparation. I will therefore mention in this place only Mr. W. A. Skidmore, of San Francisco, who has superintended the collection of information for the chapter of California, with his usual industry and discrimination; and Mr. A. Eilers, my deputy, of the great value of whose assistance it is scarcely necessary for me to speak, since evidences of his professional ability and faithful labors are impressed upon so many chapters, particularly in the metallurgical portion of this report.

After returning from New Mexico, in the month of July, I spent ten weeks in a rapid journey through Germany, where I was able, at Vienna and elsewhere, to meet with leading mining engineers and metallurgists of the Old World, and to set on foot inquiries and exchanges of information, some of the fruits of which appear in the present report, while others, yet more valuable, may be expected in time to come. It is a pleasant duty to record with what cordiality the representatives of foreign governments, schools and industrial establishments everywhere received me, as the representative of a country the resources, progress, and institutions of which are looked upon abroad with intense and unabating interest. The United States Reports on Mines and Mining have for years been quoted and discussed, and in large part translated, by the scientific writers of Germany; and the general features of our western mining industry are almost as widely known in that country as they are in this. The dissemination of such information in foreign countries has had the effect of drawing to our shores skilled mechanics, miners, furnacemen, &c.—a most valuable class of immigrants, and one which the mere display of agricultural resources would not attract. For this reason, as well as for considerations of obvious and immediate benefit to our own citizens, I trust the present policy of the Government in the publication of these reports will be continued.

I have the honor to be yours, respectfully,

ROSSITER W. RAYMOND,
United States Commissioner of Mining Statistics.

Hon. WM. A. RICHARDSON,
Secretary of the Treasury.

PART I.

CONDITION OF THE MINING INDUSTRY.

CHAPTER I.

CALIFORNIA.

The collection, in the State of California, of statistical and descriptive matter for the present report has been attended with more than usual difficulties and disappointments. The system of circulars and blanks which has been tried on former occasions, in the absence of adequate means for the employment of competent resident correspondents, has received another faithful trial resulting in almost total failure. Even those owners and superintendents of mines or mills who would be quite ready to furnish information orally on personal solicitation or to permit a free inspection of their works by a competent reporter have declined or neglected to respond to written requests. It is much to the credit of my agent, Mr. W. A. Skidmore, that he has been able, in the face of such embarrassments, to prepare a tolerably full and trustworthy account of the mining industry of the State. An acknowledgment should also be made to several friends who have afforded him valuable assistance, and particularly to Mr. Charles Gale, who has assisted in the preparation of the matter relating to quicksilver; Mr. T. M. Balch, who has furnished valuable information relative to the coal, and Mr. James D. Hague, who has done the same for the iron of Sierra County; and to Dr. Henry Degroot for important data. Special thanks are due, also, to Messrs. J. H. Crossman, of Auburn, Placer County; Mr. J. H. Becket, of Grass Valley, Nevada County; Mr. John Rathgeb, of Calaveras County; and Mr. Lewis Chalmers, of Alpine County. Due credit is given elsewhere to other contributors.

The product of the State for 1873 is estimated by Mr. Valentine, superintendent of Wells, Fargo & Co.'s Express, as follows:

Gold-dust and bullion by express	$15,709,956
Gold-dust and bullion by other conveyances	1,570,995
Silver bullion by express	264,771
Ores and base bullion by freight	480,000
Total	18,025,722

DEEP PLACER MINING.

This branch of mining has attracted more than usual attention during the past year, both at home and abroad. From all parts of the State I hear of the consolidation of claims in the hands of large companies and the commencement of extensive works of development, while in other claims of magnitude, such as the North Bloomfield, Milton, and Union, in Nevada County, and others in Sierra and Plumas Counties, the preliminary work of years is rapidly approaching completion. Once opened, these mines pay with more regularity and certainty than any other class of mining, and are, therefore, in great favor with English investors in mining property.

It is a matter of difficulty to obtain the results of American hydraulic claims, since most of them are not incorporated. No printed reports are made, and sometimes no accounts are kept. The details of the operations of some of the largest companies will be found under the headings of the respective counties in which these properties are situated, particularly under the heading of Nevada County, where the extensive works of the North Bloomfield Company are described in detail.

The mode of occurrence, methods of working, and probable origin of these vast accumulations of auriferous gravel, generally known as Deep Placers, have been frequently described in former reports. Nevertheless, in view of the increasing attention these deposits are receiving, manifested by the investment of large sums in mining enterprises of this class, and in view of the fact that each report falls into the hands of many new readers, I have deemed it advisable to publish such descriptions as may throw light on this interesting subject. A report made during the year 1873 to an English company, by Professor B. Silliman, of New Haven, and which has not been published in this country, contains an excellent summary, part of which is here quoted:

> *Theory of formation.*—It is susceptible of proof from numerous well-established facts that at the close of the geological epoch just prior to the appearance of man upon the earth, the whole of the western slopes of the Sierra Nevada Mountains, the Alps of California, were, below a certain horizon, covered by a vast spread of alluvium, owing its origin, probably, to the action of extensive glaciers, which have left the evidence of their former presence everywhere in the higher Sierra. The glaciers furnished the transporting power that brought from above the fragments which, by long-continued action of running water, were worn into the smoothly rounded bowlders, gravel, and sands forming the gold-bearing alluviums.
>
> The melting of the glaciers, as their lower skirts reached the warmer zones, furnished the water for these ancient rivers, whose beds are now found far above the level of the present river-system, and whose courses are generally crossed by the valleys of the modern streams. This condition of things continued long enough to permit the accumulation of beds of gravel, the gold-bearing alluvium, to a depth and extent unknown anywhere else in North America; and, if we speak of auriferous deposits, unequalled elsewhere in the world. Of the thickness of this accumulated material we have evidence in numerous places, where it has been protected from the action of subsequent denudation by a capping of volcanic materials. In many such places it reaches a thickness of 500 feet. Usually, however, it has been denuded to one-half of this thickness, often less; and in many regions has been swept completely away.
>
> Subsequent to the glacial and alluvial epoch to which the gold-bearing gravels are referred, there was a period of intense volcanic activity, the evidence of which is seen most conspicuously in the Table Mountains of California, so called, which are cappings of basalt forming highly characteristic ranges, which portions of the ancient gold-bearing gravels are extensively explored in Tuolumne County by tunnels driven beneath the basalt cappings into the ancient river-beds.
>
> Following the outpourings of the volcanic matter there has evidently been an epoch of very active denudation by running water which has broken up and removed the volcanic cappings, leaving them entire only here and there as landmarks showing the ancient levels, and sweeping away also vast areas of the old alluvium and redistributing it as secondary or shallow placers at lower levels. This denudation was probably consequent on the sudden disappearance of the vast system of glaciers which up to that time crowned the entire range of the Sierras with ice. It was greatly more energetic in the southern portion of the Sierras than in the northern, where the mass of ancient alluvium remaining is much greater than it is in the former region. The extent of the ancient alluvium, as well as the energy of the power which produced it originally, and subsequently denuded it, becomes apparent on a study of the phenomena, carrying to the mind an overwhelming conviction.
>
> These extensive deposits of gold attracted the attention of the early adventurers in California, and were called "hill diggins;" but their real nature and significance were not at first fully understood, and, being generally much above any sources of water-supply then available for washing, they received but little attention. Especially were they overlooked while the rich spoils derived from their secondary removal by denudation were available, with no other means than the miner's pan, shovel, and pick, upon those productive "bars" of adjacent rivers and in rich "gulches" where the gold (derived in large measure from the denudation of the ancient alluvium) lay open to the first comer in a concentrated form. So complete was the removal of the gravel in some of the southern counties that the gold, left behind by its weight, lay

upon the naked rock, covered only by a few inches of vegetable mold, as at Mokelumne Hill, where, in the limits of a single "claim" 15 feet square, the precious metal to the amount of $50,000 has fallen to the lot of a single adventurer.

In some parts of the State, and especially in Nevada, Sierra, and portions of Placer County, the volcanic outpourings consisted of ashes and fragmentary materials, consolidated into heavy beds of volcanic mud with fragments of scoria, tufa, and basalt, which are found accumulated on the higher portions of the ridge between the Middle and South Yubas, and elsewhere, to the height of many hundred feet. Northward, above Oroville, in Butte County, the basaltic cappings occur again, similar to those of Tuolumne County, and known as Table Mountains.

Where these overlying masses or cappings of volcanic matter have been removed, or where a bank or section has been exposed by hydraulic washing, we have an opportunity of observing the different strata. The lower or bed-rock stratum generally consists of large stones and masses of water-worn rock which have apparently been torn up and moved by the action of torrents of swiftly-running water. Next above, we find rounded bowlders and pebbles, generally consisting of quartz, and strongly cemented by pressure and perhaps chemical action; and still above, alternate layers of sand, gravel, decayed vegetation, petrified wood, lignite, and a layer which is known as pipe-clay by the miners, but which is evidently a clay sediment deposited during periods of overflow in slow running water, and in all respects similar to the sediment deposited every few years by the Sacramento River, over lands adjoining its banks during periods of overflow. The conclusion is irresistibly reached by an examination of these banks, sometimes exposed to a height of 300 feet or more, that their contents were deposited at first by swift torrents, and subsequently by alternating high and low water. In some places the ancient streams seem to have widened into lacustrine expansions, and here we have the phenomena of beach deposits. An instance of this is found in the Union gravel claim of Howland Flat, Sierra County, where a drift of over 1,000 feet across the channel has failed to disclose any evidence of an approach to the center of the channel, which would be evidenced by a "falling off" of the bed-rock. This drift is run under a lava capping many hundred feet in thickness.

Character of the deposits.—The term "blue-gravel" has come into general use among hydraulic miners, to distinguish in general between the upper or poorer beds of the deposit and the lower and richer portions which have often, but not always, a peculiar bluish color that has come to be considered characteristic of the rich portions of the gravel. The bluish color is due to the reducing power of organic matter, chiefly vegetable fiber, acting upon the salts of iron present. The latter have become the principal cementing material, compacting the gravel and sand into a firm conglomerate so strong near the "bed-rock," as sometimes to require the use of gunpowder to prepare it for action of the water. When exposed to the action of the air and atmospheric waters, this blue color disappears and the mass becomes yellowish and reddish, and sometimes brilliantly colored with various tints of purple and red. It loses at the same time a great part of its firmness and often crumbles to powder, even the pebbles of a certain sort "slacking" to a sandy consistency. The blue color has no necessary connection with the presence of gold, the fact being that the deposit is richer in gold as it nears the "bed-rock," and that the cementing material is bluish only because it has been beyond oxidizing influences.

The term "great blue-lead" is employed by the miners to distinguish those portions of the alluvium which are found to rest in a well-defined channel, on the "bed-rock" which, not without good reason, is assumed to have been the path or channel of an "ancient river." That there were many, such ancient rivers is clearly proved by what is already known of the topography of that portion of the gold region where the auriferous gravels exist. There are obvious reasons why, as a rule, the beds or channels of such streams should be richer than the general surface beyond their banks.

The bed-rock is what the name implies, the floor on which the gravel rests—and it varies, of course, with the general geology of the country. At Smartsville it is a compact, fine, granular green-stone or trap. In the neighborhood of North San Juan, in Nevada County, it is granite, or rocks of the granitic family, succeeded by slates, as at Quaker Hill and Blue Tent. In Sierra County it is often serpentine or talcose rocks; but whatever the bed-rock may be, it is invariably, when first uncovered, found to be smoothly worn by water, and the direction of the current may be seen by the course of the deeper grooves.

It is impossible, in the absence of a topographical map, to give any correct idea of the extent and distribution of these ancient gravel deposits to those who have not seen them. Such a map is now in process of completion by the members of the State geological survey of California, and will probably be ready for distribution early in 1874. In the absence of any official map I have given a map of a portion of Sierra, Nevada, and Placer Counties, showing the exposed portions of the great blue-lead from Snow Point to Smartsville, as well as the direction and situation of the great channel running through Nevada and Placer Counties. This map was originally compiled by Mr. A. J. Doolittle, and is published as corrected from the surveys of Hamilton Smith, jr., superintendent of the North Bloomfield Gravel Company.

The hydraulic process.—The following graphic description of the process of hydraulic mining is quoted from Professor Silliman's report:

With the more or less complete exhaustion of the shallow placers in ravines and river-beds in California, where the gold was first obtained with little labor, and by the most simple means, came the necessity of devising a system by which the deep placers, like these under consideration, could be economically worked. The accomplishing of this object demanded the use of a large amount of capital to be expended in the construction of canals and aqueducts to convey water from the mountains and fountain-heads of the streams at a suitable elevation, and in sufficient quantity to command the ground to be worked, as well as for the openings of tunnels and shafts in the bed-rock for the discharge of the gravel; an operation requiring much labor and skill, and consuming often several years in their prosecution.

The association of labor and capital thus demanded called into existence, in various parts of the State, canal and ditch companies, the associates being generally miners, whose limited finances were eked out by borrowing money from bankers at rates of interest varying from 3 to 5 per centum monthly. Experience has demonstrated that the larger the volume of water employed in the process of hydraulic mining, the more the efficiency and greater the economy of the operation. The proper application of the great mechanical force furnished by a larger volume of water under a great pressure was a problem solved satisfactorily only after many abortive trials and large experience. This problem involves the following conditions:

1st. The whole mass of auriferous gravel must be moved, whatever its depth, quite down to the bed-rock.

2d. This must be accomplished by the action of water alone, human labor being confined to the application of the water and the preliminary preparation it involves.

3d. The mechanical disintegration of the conglomerate, as a part of the uninterrupted operation of the whole system.

4th. The contemporaneous saving of the gold without interrupting the continued flow of water.

5th. The disposal of the accumulation resulting from the removal of such vast masses of auriferous gravel. These conditions are, in practice, met by the following steps:

The mining-ground being selected, a tunnel or "open cut" is projected from the nearest and most suitable ravine, or river-bank, so that, starting in the bed-rock, on the face of the ravine, or other selected point, it shall approach the center of the gravel mass to be moved at a gradient of one in twenty-four to one in thirty-six. The dimensions of this tunnel are usually six feet in width by seven feet in height, sometimes wider.

These tunnels vary in length from a few hundred feet to a mile; some of the larger consuming from two to seven years in driving, at a cost of $10 to $60 per foot, varying with the character of the rock to be excavated. The end of the tunnel is designed to reach beneath the under-surface of the gravel in the center or deepest part of the channel, at a point where a shaft or incline is sunk through the gravel until it intersects the tunnel. It obviously demands careful engineering to carry out works of such magnitude with the accuracy required, and, for the want of sufficient care or skill in this particular, years of costly labor and anxious expectation have been wasted in the early history of these enterprises. The object of this laborious exploration is obvious. The long tunnel becomes a sluice-way, through the whole length of which sluice-boxes are laid at once, to direct the stream and save the gold. For this purpose a trough of strong planks is placed in the tunnel, from 3 to 4 feet wide, and with sides high enough to control the stream. The pavement is usually composed of blocks of wood from 6 to 8 inches in thickness, cut across the grain of the wood, and so placed as to expose the end of the blocks to the wear of the current. The wooden blocks are usually alternated with sections of stone pavement, the stones set endways. In the interstices, quicksilver is distributed, as much as two tons of this metal being required to charge a long sluice. The water from the canal is brought, by side-flumes or aqueducts, to the head of the mining-ground, with an elevation of 200 to 500 feet above the bed-rock, and it is conveyed into the bottom of the claims by iron pipes sometimes sustained on a strong incline of timbers. These pipes are of sheet-iron of adequate strength, riveted at the joints, and measure from 12 to 20 inches in diameter. These connect with a powerful apparatus of sheet-iron provided with a universal joint, to which the outlet or "nozzle" is attached, ending in a steel ring for the delivery of the water, which varies from 4 to 8 inches in diameter, as greater or less volume of water is used.

From these nozzles the streams are directed against the face of the gravel "bank" to be washed with a force comparable with that of ordnance. The volume of water employed varies, of course, with the work to be done, but it is not uncommon to see four such streams, each conveying 300 to 600 inches of water, or more, acting simultaneously on the face of the same "bank." One thousand miners' inches of water are equal to 106,600 cubic feet of water per hour, constantly discharged under a pressure of 100 to 200 pounds to the square inch, varying with the height of the column, or pressure. Under the continuous action of this enormous mechanical force, aided by the softening influence of the water, large sections of the gravelly mass come crashing down with great violence.

The *debris*, speedily dissolving and disappearing under the resistless force of the torrent of water, is hurried forward in the sluices, precipitated with the whole volume of now turbid water down shafts, or dumps, prepared for the purpose, and then taken up again by the sluices, where it is brought, by means of undercurrents, riffles, and other appliances, in contact with the quicksilver, and thus made to give up its gold. Bowlders of 100 to 200 pounds in weight are shot forward by the impetuous stream together with masses of the harder cement, which meet, in the fall and concussion of the great bowlders, the crushing agencies required to disintegrate them.

The deeper banks of gravel are usually worked in two benches. The upper is never so rich as the lower, and, being also less firm, is worked away with greater rapidity. The lower section is much the most compact; the stratum on the "bed-rock," being strongly cemented by sulphuret of iron and great pressure, resists even the full force of the water stream, until it has been loosened by gunpowder. For this purpose adits are driven in on the bed-rock 40 to 70 feet from the face of the bank, and a tunnel extended at right angles therefrom to some distance each side of the adit. In this tunnel a large quantity of gunpowder is placed, from one hundred to three hundred kegs, and fired as one blast by a train laid without. In this manner the compact conglomerate is broken up, and the water then rapidly completes the work.

The sluices are often made double, for the convenience of "cleaning up" one of them while the other is in action. The process of "cleaning up" is performed, according to the extent of the works and the richness of the material washed, at intervals from fifteen to thirty days, and consists in removing the pavement and blocks from the bed of the sluice, and gathering the amalgam of gold and "rich dirt" collected in them, and replacing the blocks in the same way as at first. Advantage is taken of this occasion to reverse the position of the blocks and stones forming the pavement, when they are worn irregularly, and to substitute new ones for those which are worn through.

The mechanical action of the washing process on the blocks is, of course, rapid and severe, so as to require a complete renewal of them once in eight or twelve weeks. Some miners prefer a pavement of egg-shaped stones set like a cobble-stone pavement, the gold being deposited in the interstices. Most of the sluices are, however, paved with rectangular wooden blocks, with or without stones, as described above.

Standing at the mouth of one of these long sluices, in full action, one unaccustomed to the process is filled with a sense of amazement, amounting almost to terror, as the muddy mass sweeps with great velocity onward, bearing in its course bowlders which add their din to the roar of the waters, the whole being precipitated down a series of falls or dumps at each of which it is caught up again by a new sluice of timber, lined as before explained, and so onward and downward many hundreds of feet, until the level of the river is reached, a mile or more from the "bank." At each of these falls of 25 to 50 feet the process of comminution, begun in the first, is carried forward, and a new portion of gold obtained.

Rude as this method of saving the gold appears, experience shows that more gold is saved by it than by any other method of washing yet devised; while the economical advantages it offers are incomparably greater than any other. In fact, it would be entirely impossible to handle so vast a body of material in any other way now known. To show the enormous advantage gained by the present systems of working, compared with those formerly in use, taking a miner's wages at $3 per day, the cost of handling a cubic yard of auriferous gravel is as follows: with the pan, $15, with the rocker, $3.75, with the long tom, 75 cents, with the hydraulic process, 10 cents. In fact, man has in the hydraulic process taken command of nature's agencies, employing them for his own benefit, compelling her to surrender the treasure locked in the auriferous gravel by the use of the same forces which she employed in distributing it. Certainly by no other means does man more completely change the face of nature than by this method of hydraulic mining. Hills melt away and disappear under its influence, being distributed in the river-beds below, every winter's freshets carrying to lower and yet lower points the *detritus*, while whole valleys are filled with clean-washed bowlders of quartz and other rocks left behind in the general debacle. Meanwhile, the Sacramento and its tributaries flow turbid with red mud, bars are formed where none existed before, and the hydrography of the bay of San Francisco is changing under the influences of the same causes. The desolation which remains after the ground washed by the miner is abandoned is remediless and appalling. The rounded surface of the bed-rock torn up with picks and strewn with great bowlders shows, here and there, islands of gravel rising in vertical cliffs, with red and blue stains serving to mark the ancient level, and filling the spectator with amazement at the changes, geologic in their nature and extent, which the hand of man has wrought.

Yield of the placers.—The question of the average yield of the gravel deposits of California has attracted much attention during the year, having been the subject of discussion on the part of a leading newspaper and a prominent magazine, neither of which, however, developed any new facts on this interesting subject.

During a recent visit to the gravel region between the Middle and South Yuba, Mr. Skidmore, my agent, took some trouble to investigate this subject, and give the results, at least so far as prominent claims are concerned, where the facts are attainable. In this matter he is indebted for assistance to Mr. Hamilton Smith, jr., of the North Bloomfield Gravel Company, of Nevada County, who has furnished copies of his memoranda relative to tests made on the grounds of that company.

At the North Bloomfield claim two hundred and forty samples, selected from various points on the surface and on the exposed banks of the workings, were carefully "panned," and each sample or pan so taken showed one or more "colors" to the pan. In no case was there a failure to obtain a color. Each pan contained from one-fourth to one-third of a cubic foot of dirt.

At the "prospecting shaft" of the same claim, two hundred feet in depth, the following method of sampling was adopted: A small bucketful of dirt was taken from between every two sets of timbers—*i. e.*, at intervals of eight feet—from both shaft and drifts. This dirt was selected from top and bottom of the drifts, and from all the various strata passed through in sinking the shaft, with a view of obtaining an average of the dirt exposed in the ground opened by these works. In this manner two hundred and four samples, weighing in the aggregate 5,027 pounds, were taken from 1,632 linear feet of drifts, running up and down the channel. These were carefully panned, with the following results: 5,027 pounds of dirt and gravel yielded 0.0145 ounce of gold, valued at $2.75, or at the rate of $1.10 per ton. This test of course included the richer class of gravel on the bed-rock, and is the most thorough and careful test by hand-panning which has come under our observation.

The returns from the workings of the following claims are calculated from actual measurement and the records of the respective companies:

Kansas Company, French Corral, Nevada County.—This company owns 450 linear feet on the channel. The bottom gravel being strongly cemented was run through a stamp-mill. The product of 67,500 cubic yards of gravel was $223,000, or $3.33 per cubic yard. The top dirt, washed by the hydraulic process, yielded $45,000. The aggregate yield of the claim was $268,000, or at the rate of $6 per linear foot of channel.

Empire Company, French Corral, Nevada County.—Bottom gravel, of same nature as above, crushed by the mill process, yielded at the rate of $6 per cubic yard.

Nebraska Company, French Corral, Nevada County.—Same character of gravel worked by mill process. The mill—10 stamps—in eleven days crushed 600 tons, which yielded $9,000, or $15 per ton.

American Company's Claims, Sebastopol, Nevada County.—Up to the close of the year 1871 there had been washed by the hydraulic process 6,000,000 cubic yards, which yielded $1,800,000, or 30 cents per cubic yard. The gravel banks have an average height of 120 feet, and a granite bed-rock. From 1871 to 1873 the yield has been from 25 to 30 cents per cubic yard.

Blue Tent Company's ground, Nevada County.—The top dirt of several claims now owned by this incorporation, estimated by civil engineers as 5,138,150 cubic yards, washed by the rude hydraulic process in use before the invention of the improved appliances, yielded $780,000, or a trifle over 15 cents per cubic yard.

Blue Point Company, Smartsville, Yuba County.—Two runs, aggregating ninety days, during which time 93,944 cubic yards were washed, yielded $115,728, or $1.25 per cubic yard. The banks had an average height of 57 feet. This run probably cleaned up an extensive area of bed-rock, and is exceptional.

Mr. Amos Bowman has made careful measurement and estimates of the amount of ground washed, the product and the average yield, at Smartsville, Yuba County, and obtains the following results, which are given in the round numbers approximating the actual figures:

Estimated results of early surface washing	$4,000,000
Results of deep workings	6,000,000
Quantity of ground washed	25,000,000 cubic yards
Gravel remaining in place	100,000,000 cubic yards

From this it would appear that the average yield of the ground worked since the introduction of improved hydraulic machinery has been about 25 cents per cubic yard, being somewhat higher than heretofore supposed.

Those who are interested in the subject will find additional facts in my report of 1872, pages 119, 120.

It will, however, be borne in mind that these are favored localities, and an estimate of the contents per cubic yard or ton of the entire auriferous deposit between the Yubas, on this basis, would be extravagant.

Hydraulic gravel mining is considered the most certain and reliable of all mining when the deep gravel has been reached and worked by such a system as will enable the miner to clear the channel to the bed-rock. The deposit is virtually inexhaustible, and as wages and supplies cheapen in price, and new and improved appliances and facilities are brought to bear, the profits of working steadily increase.

To a casual observer traveling through the hydraulic mines and gravel districts, little would appear except streams of water playing against high banks of gravel with enormous excavations. But one who visits them under the invitation of the owner, with an intention to investigate, and who is willing to take the trouble of examining closely, will be astonished at the magnitude and extent of the underground works, as well as at the lavish expenditure of money upon reservoirs, ditches, flumes, sluices, pipes, tunnels, shafts, and all the expensive appliances necessary to such operations.

Tailings.—In the river-beds, cañons, and gulches which have formed the outlet of hydraulic mines since the commencement of this class of mining are large accumulations of "tailings," rich in gold, which escaped under the primitive processes of washing formerly in use. The percentage of loss of gold and quicksilver under those rude methods of washing has been estimated at from 25 to 33 per cent. of the gold released. This, of course, has run off in the tailings. These tailings have choked up and obstructed the natural outlets to such an extent as to seriously interfere with the working of the hydraulic ground above them.

During the year 1873, Dr. Henry Degroot, of San Francisco, visited several of the prominent mining regions of California, with a view to investigate, in the interest of the Bear River Flume and Tunnel Company, the past experience of miners in this class of operations. From his report are taken the following extracts:

> Washing for gold along the streams of California commenced in the fall of 1849, operations having been carried on at first with the pan and rocker, or other equally rude utensils; these primitive and comparatively inefficient implements having been largely superseded in the course of a year or two by the long-tom and the sluice, and these again, not long after, by the still more efficacious, but wasteful, hydraulic process. For several years no quicksilver was used, and the miners, eager to run off as much dirt as possible, were in the habit of using much water and working their apparatus on a very steep grade. As a consequence, the most of the fine, and even a large percentage of the coarse gold contained in the gravel taken from the gulches and river-bars, passed through their machines, and, escaping into the swift-running water, was deposited along the beds of the streams farther down.
>
> Heading below the more elevated ridges of the Sierra, and carrying therefore a less volume of water, the creeks and rivers in this neighborhood have worn for themselves only moderately deep channels and run with less swiftness than the larger and more precipitous streams. For the same reason the banks and bars were here originally very rich in gold, the force of the current not being strong enough to carry it far down-stream. So, too, the tailings emptied into these creeks and rivers were deposited along their beds soon after passing from the sluices. Hence, these streams began to fill up early, this process having set in so soon and proceeded so rapidly that much of the gold-bearing gravel upon their banks was covered up and never afterward reached; nor have their beds, except in a few favorable localities, ever yet been thoroughly worked out. With each succeeding year these deposits have been covered deeper and deeper, until the chance of removing them before these channels have first been emptied of their contents has become utterly hopeless. As mining operations above increased in magnitude, so did the volume of this *debris* go on accumulating, till it has come at last to so obstruct some of the best hydraulic claims as to render them worthless, and threatens to soon close up many others.
>
> These tailings began their encroachments along the streams more than twenty years since, making lodgment during the summer to be partially swept away by the winter-floods, each year adding something to the quantity left by its predecessor, until, the channels being filled, the banks themselves were finally covered up, and many a rood of rich ground was buried beneath the constantly-accumulating tide of slums poured out from the sluices above. Never, since they began to collect, have they been more than partially removed, the winter-floods having merely carried off the lighter and poorer stuff on top, lowering the mass from 10 to 20 feet of a season, and thus leaving the balance in a highly concentrated form. This action of the water, while floating off the worthless material, has kept the surface-gravel in a ceaseless state of agitation, thereby working the gold, quicksilver, sand, and sulphurets constantly to the bottom, where rich deposits may be looked for. In accordance with this theory, it follows that the further this gravel has been carried down stream, the less gold and qucksilver it will be likely to contain, the weight of these metals, and more particularly the mobility of the latter, causing them to seek the bed-rock before they have traversed any great distance.
>
> In addition to the free gold known to have been lost, such quantities of quicksilver

and auriferous sand and sulphurets have been carried out of the miners' sluices, as well as from the batteries of the cement and quartz mills, and lie now mixed up with these tailings, as would justify their being rewashed for these substances alone. It is estimated by hydraulic miners that from one to five tanks* of quicksilver are lost to every run of any magnitude, the quantity depending upon the amount of gravel put through, the length of the run, &c.; it being further calculated that each tank of this metal escaping carries with it about $100 worth of gold. It is a well-attested fact that some large hydraulic companies in Little York Township have lost as much as twenty-five tanks of quicksilver in a single season, and with it, of course, a corresponding amount of gold.

There is not a cubic yard nor yet perhaps a foot of these tailings but will yield, under pan-washing, a fair prospect, and very often a notable quantity of gold. Examine them where we will, up near the diggings or many miles below, on the surface or near the bottom, and an appreciable quantity of the precious metal will be found disseminated through them. How much gold was buried up here in the early days, without having been disturbed, or how much has been carried down and lodged in these tailings since, is, outside of certain limits, mere matter of conjecture, those best qualified to judge entertaining on this point a great diversity of opinion.

As examples of what was sometimes effected washing over these tailings in a small way, the following are cases in point: In 1866 there was cleaned up, along 500 feet of the Greenwell claim, on Birdseye Creek, this being the extent to which the bed-rock could there be freed of tailings, the sum of $96,000, forty-two thousand of which consisted of net profits. The main items of expense were labor and water, then much higher than at present, the latter costing nearly twice as much as it now does. This amount was extracted from the tailings alone, none of the original gravel having been left here; in fact, the bed-rock itself had before been cleaned up and closely creviced. Birdseye Creek is a small and rapid stream, and even now contains but an inconsiderable body of tailings at the point where this work was done, nearly three-fourths of a mile above its junction with Steep Hollow. At that time there was not a third of the tailings in this Creek that have since been lodged, and are now lying there, and none of which, except the small quantity mentioned, has ever been subjected to a second washing.

In 1865 a short line of sluices was laid in the Kissell claim, near the lower end of Missouri Cañon. After a few feet of the surface had been washed off by ground-sluicing the tailings were shoveled into, and run through this short string of boxes, and yielded at the rate of $185 per day, a force of ten men being employed. The gravel washed here lay 40 feet above the bottom of the cañon, and was therefore of a much poorer quality than that underneath. A similar apparatus was about the same time set to work in this cañon at a point a little higher up; but a freshet occurring while operations were in progress, this sluice, charged with over $7,000, was covered up so suddenly, and to such a depth, that neither the structure itself nor its contents could be saved, nor have either since been exhumed from their slimy bed.

More recently, 300 feet of the tailings along Arkansas Cañon cleaned up to a width of 20, and to a depth of 18 feet, yielded within a trifle of $7,000—five thousand three hundred clear of expenses. Examples to the same purport might be indefinitely multiplied—the instances cited being sufficient to illustrate a class of facts numerous and patent in this section of the mines.

There is little reason to apprehend an abatement of the supply, and as little cause to fear the early exhaustion of the material. The region ramified by the streams that are to receive and bring to hand the auriferous debris comprises many thousands of acres, a large portion of which is covered with lofty banks and deep-lying beds of gold-bearing gravel; the quantity being such, that the inroads made upon it by twenty years of active working have done little more than fairly prospect it. To speculate about the length of time required to exhaust these deposits, is to deal with the results of a very remote future.

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* Query: flasks?—R. W. R.

Mining ditches in California.

Counties.	1872.			1873.		
	Number.	Miles in length.	Amount of water used per day.	Number.	Miles in length.	Amount of water used per day.
			Inches.			*Inches.*
Amador	46	470	5,980	9	148	12,000
Butte	10	219	30,600	11	285	5,000
Calaveras	22	482	3,050	22	400	3,670
Del Norte	25	42	3,300	30	114	2,200
El Dorado	54	850	6,720	54	850	6,720
Fresno	....	2	40	3	5	....
Inyo	....	....	....	4	50	10,000
Klamath	60	100	10,000	70	90	15,000
Lassen	3	8	400	5	12	700
Los Angeles	4	21	2,860	4	21	2,860
Mariposa	10	66	....	(*)	(*)	(*)
Mono	1	4	300	1	4	300
Nevada	74	667	36,225	76	707	38,000
Placer	52	364	....	53	417	14,110
Plumas	....	800	25,000	30	200	20,000
Sacramento	4	97	5,700	5	97	5,700
San Bernardino	1	3	130	1	4	130
Shasta	86	363	12,250	78	325	11,650
Sierra	50	213	2,800	50	213	2,800
Siskiyou	18	220	10,800	18	290	9,000
Stanislaus	2	10	500	2	14	500
Tehama	1	7	160	(*)	(*)	(*)
Trinity	224	430	47,850	225	422	46,950
Tuolumne	4	100	2,400	4	100	2,400
Yuba	21	80	5,000	20	75	4,500
Total	772	5,618	214,065	775	4,863	214,190

* No returns.

The day referred to in the above table is probably the working day of ten or twelve hours; and the miners' inch is the quantity flowing through one square inch of aperture under six inches head, or about 2⅛ cubic feet per minute.

This industry depends so directly on the rain-fall of each year, that the following table will be an interesting explanation of its fluctuating condition in that respect:

Rain-table for Sacramento, arranged according to the seasons, showing the amount in inches during twenty-four years for each rainy season.

[Prepared by T. M. Logan, M. D.]

Years.	Total.	Years.	Total.	Years.	Total.	Years.	Total.
1849-'50	36.000	1855-'56	13.770	1861-'62	35.549	1867-'68	32.769
1850-'51	4.710	1856-'57	10.443	1862-'63	11.579	1868-'69	16.644
1851-'52	17.920	1857-'58	18.991	1863-'64	7.868	1869-'70	13.572
1852-'53	36.365	1858-'59	16.041	1864-'65	22.512	1870-'71	8.470
1853-'54	20.065	1859-'60	22.626	1865-'66	17.924	1871-'72	24.052
1854-'55	18.620	1860-'61	15.548	1866-'67	25.305	1872-'73	14.298

Maximum quantity of rain in each month, minimum in each month, and average quantity in each month, at Sacramento, since 1849.

Quantity.	January.	February.	March.	April.	May.	June.
Maximum	15.0 (1862)	8.5 (1854)	10.0 (1849)	4.3 (1853)	2.5 (1860)	0.4 (1857)
Minimum	0.6 (1852)	0.1 (1852)	0.5 (1865)	0.0 (1857)	0.0 (1857)	0.0
Mean	3.5	2.7	3.0	1.6	0.8	0.0

Maximum quantity of rain in each month, &c.—Continued.

Quantity.	July.	August.	September.	October.	November.	December.
Maximum	0.5 (1860)	0.0	1.0 (1851)	3.0 (1858)	6.7 (1864)	13.4 (1852)
Minimum	0.0	0.0	0.0	0.0	0.0 (1850)	0.0 (1850)
Mean	0.0	0.0	0.0	0.4	1.9	5.4

QUARTZ-MINING.

The business of mining on the gold-bearing-quartz ledges of California has been prosecuted with great energy, and has been attended with more than ordinary success, as will be seen by reference to the following exhibits. Many of our leading mines have maintained their reputation; others of no previous record have been placed on the list of dividend-paying mines, while there are but few instances of failure to record. The reports of the Idaho and Eureka, of Grass Valley, which have long maintained their reputation as the leading mines of California, will be found in full under the heading of "Nevada County," while the returns of other prominent mines will be found under the heading of the county in which they are situated.

The following table shows the gross yield and dividends of the Idaho for the last five years:

Years.	Gross yield.	Dividends.
1869	$306,038 75	$170,500 00
1870	183,450 23	37,200 00
1871	407,301 16	232,500 00
1872	404,035 53	162,750 00
1873	1,010,612 20	682,000 00
Total for five years	2,311,437 86	1,284,950 00

The Eureka, of Grass Valley, has paid dividends as follows:

1867-'68	$290,000
1868-'69	264,000
1869-'70	400,000
1870-'71	360,000
1871-'72	....
1872-'73	260,000

This mine has disbursed in dividends, up to the close of 1873, the sum of $2,094,000.

The following statement shows the dividends for the year 1873 of California quartz-mines having offices in San Francisco:

Consolidated Amador, Amador County	$150,000
Cederberg, El Dorado County	48,000
Eureka, Nevada County	300,000
Idaho, Nevada County	682,000
Keystone, Amador County	185,000
Black Bear, Klamath County	45,000

Many other mines, such as the Chariot, of San Diego County, and the Hite mine, of Mariposa, belonging to private parties, have yielded large dividends to their owners. For additional information on these points, obtained too late for insertion at this place, the reader is referred to the concluding chapter of the present volume.

Several of our leading quartz-mines have within a few years passed into the possession and ownership of English companies, and are incorporated in London.

The following tables will show the condition of these mines:

Statement showing operations of mines of California, owned in London, for the year 1873.

Mine.	County.	Owner.	Total number tons raised.	Total number tons worked.	Average yield per ton.	Total bullion-product.	Average number of stamps employed.	Cost of mining, per ton.	Cost of milling, per ton.	Company or custom mill.	Miners' wages per month.	Number of miners employed.	Remarks.
Black Bear	Klamath	Corporation	8, 800	5, 800	$20	$116, 402	20	$6 50	$1 20	Co	$60	80	Did not run all the time, more stamps being added.
Plumas Eureka	Plumas	do	8, 000	7, 900	15	117, 500	40	4 50	85	Co	60	150	New mill; did not run the whole year.
Sierra Buttes	Sierra	do	38, 827	40, 035	9	368, 964	72	3 60	80	Co	50	250	

List of producing mines in California, owned in London.

Name.	Owner.	Location.	Course.	Dip.	Depth main shaft.	Country-rock.	Vein-matter.	Average value per ton.	Per cent. sulphurets, per ton.	No. tons extracted and milled during year ending July 1, 1873.
Black Bear	Corporation	Black Bear, Klamath County	N. and S.	E.	Opened by adits; no shaft.	Slate	Quartz and slate	$20	2½	8, 800
Plumas Eureka	do	Jamison, Plumas County	N. and S.	E.	do	do	do	15	1	8, 000
Sierra Buttes	do	Sierra City, Sierra County	E. and W.	N.	do	do	do	9	½	40, 000

Statement showing operations of leading quartz-mines of California for the year 1873, reported by W. A. Skidmore.

Mines.	Owners.	Total number of tons raised.	Total number of tons worked.	Average yield per ton.	Total bullion product.	Number of stamps employed.	Cost of mining per ton.	Cost of milling per ton.	Company or custom mill.	Miners' wages per day.	Number of miners employed.	Remarks.
NEVADA COUNTY.												
Idaho mine	Idaho Quartz-Mining Company	27, 624	27, 624	$37 91	$1, 024, 501	35	......	......	Co..	$3 00	148	The cost of milling and mining was $8.61 per ton.
Empire mine	Empire Mining Company	8, 000	8, 000	25 00	240, 000	20	$17 50	$1 50	Co..	3 00	80	
Eureka mine	Eureka Quartz-Mining Company	7, 820	7, 852	62 00	486, 854	30	12 71	1 94	Co..	3 00	115	The average yield of the sulphurets was $80.57 per ton.
Nevada mine	J. S. Van Winkle & Co	4, 000	4, 000	5 50	22, 000	8	3 50	1 00	Co..	3 00	8	
Providence mine	Walrath, Smith & Co	4, 500	4, 500	10 00	45, 000	10 to 20	2 75	1 25	Both	3 00	22	This company have a ledge of from 40 to 50 feet in width.
North Star mine	North Star Mining Company	7, 500	7, 391	20 00	150, 000	24	11 00	3 00	Co..	3 00	75	
AMADOR COUNTY.												
Consolidated Amador	Amador Mining Company	18, 000	18, 000	20 00	363, 898	10 to 40	......	1 75	Co..	3 00	60	Now opening the 1,700-foot level.
Kennedy	Kennedy Mining Company	5, 000	5, 000	16 00	....	20	4 00	2 40	Co..	3 00	6	The cost of milling is owing to the use of light stamps—450 pounds.
KLAMATH COUNTY.												
Black Bear	London Company	8, 800	5, 800	20 00	116, 402	20	6 50	1 20	Co..	3 00	80	Are now adding additional stamps.
PLUMAS COUNTY.												
Plumas Eureka	London Company	8, 000	7, 900	15 00	117, 500	40	4 50	85	Co..	3 00	150	
SIERRA COUNTY.												
Sierra Buttes	London Company	38, 827	40, 035	9 00	368, 964	72	3 60	80	Co..	*50 00	250	

* Per month.

Mills on California mines owned in London.

Name of mill and owners.	Location.	Power—steam or water.	Horse-power engine.	Number of stamps.	Weight of stamps.	No. drops per minute.	Height of drop.	Number and kind of pans.	Number and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours.	Crushing capacity of mill per 24 hours.	Loss mercury, p'r ton.	Cost treatment, per ton.	Running time.
					Pounds.		*Inches.*				*Cords.*	*Tons.*			
Black Bear, (Black Bear Quartz Mining Company.)	Black Bear, Klamath County.	Both ...	60	28	550	70	9	1 Stevenson .	2 Hendy	$36,000	4	38	....	$1 20	6 months.
Eureka, (Plumas Eureka Mining Company.)	Jamison, Plumas County.	..do	100	40	780	80	9	2 Patton	....do	100,000	7	90	....	85	3 months.
Sierra Buttes, (corporation.)															
Reis Mill	Sierra City	Water..	......	16	650	78	8	None	None	15,000	....	30	....	66	12 months.
Hanks Mill	... do...........	..do	......	30	780	76	8¼	1 Patton	2 Hendy	50,000	....	60	....	71	Do.
Hitchcock Mill	....do...........	..do	......	40	700	70	8	1 Hepburn . 1 Stevenson	....do	45,000	....	70	....	88	Do.

Quartz-mills in California, from reports of County assessors.

Counties.	1872.		1873.		Counties.	1872.		1873.	
	Number.	Tons crushed.	Number.	Tons crushed.		Number.	Tons crushed.	Number.	Tons crushed.
Alpine	4	....	5	....	Nevada*	46	105,633	....	....
Amadore	24	252,000	15	81,000	Placer	12	9,000	14	22,750
Butte	17	....	8	10,000	Plumas	14	30,000	8	33,500
Calaveras	26	37,105	34	28,960	San Bernardino	2	....	2	....
El Dorado	40	....	40	....	San Diego	7	10,000	7	10,500
Fresno	2	100	....	....	Shasta	5	800	2	500
Inyo	3	8,000	3	5,000	Sierra	24	74,000	24	68,000
Kern	13	8,000	15	....	Siskiyou	3	3,000	3	1,000
Klamath	4	6,000	3	10,000	Tulare	2	300	2	500
Lassen	1	75	1	200	Tuolumne	20	7,000	23	12,000
Los Angeles	1	3,000	1	5,000	Yuba	4	....	....	....
Mariposa	34	18,000	....	....					
Mono	3	900	3	1,400	Total	311	572,913	213	290,310

*It will be observed that there are no returns for the year 1873 from the counties of Nevada and Mariposa. These counties had, in 1872, 80 mills, and crushed an aggregate of 123,633 tons quartz. The large gold-product of California for the year 1873 is evidently due to the increased activity in hydraulic mining.

QUICKSILVER.

A prominent feature in the mineral development of California during the year 1873 has been the great number of new discoveries of cinnabar-ore. A notable fact in connection with these discoveries is, that the quicksilver product of the State has at the same time declined materially. This being the case, of course the article has risen greatly in price, having advanced from 90 cents in January to $1.20 per pound in December. This is due to the decreased production of the principal mines, to which we have looked for the bulk of quicksilver produced in the State. As California is the only State in the Union which yields this necessary article, it is to be hoped that some of the numerous deposits found during 1873 will in time rival the famous old mines. The price of quicksilver exercises an important influence on the mining interests of all the Pacific coast States and Territories, and its production at a cheap rate is a matter of great interest to the mining population. Competent authorities estimate that the present consumption on the Comstock lode alone amounts to about 800 flasks per month, or three-fourths of a million pounds per annum. Including this, the entire State of Nevada is estimated to consume about 1,100 flasks per month, or nearly 1,000,000 pounds per annum. On inquiry at the offices of the Central Pacific Railroad Company, it is found that the greater proportion of the quicksilver carried by the road during the year went to the mills at the Comstock lode, Nevada. During eleven months of 1873 they carried as freight 415,597 pounds, of which 384,654 pounds went to Virginia City. Of the total amount carried, 35,947 pounds went east from San José, the rest from San Francisco. That from San José probably came from the New Almaden and New Idria mines. When it is remembered that in 1872 the price per pound was 85 cents, and that at present writing it is $1.20 per pound, it will be seen that this variation in price, though only a few cents per pound, makes a considerable difference to the mining community.

The following estimate of the quicksilver product for 1873, together with the export statistics, is from the Commercial Herald, of San Francisco:

	1871. Flasks.	1872. Flasks.	1873. Flasks.
New Almaden mine	18,763	17,753	12,000
New Idria mine	9,227	8,597	7,600
Redington mine	2,128	2,456	4,200
Sundry other mines	1,763	1,500	4,800
Total	31,881	30,306	28,600

The exports to the different countries for 1872, and the three previous years, were as follows:

To—	1870. Flasks.	1871. Flasks.	1872. Flasks.	1873. Flasks.
New York	1,000	800	1,202	....
China	4,050	7,900	4,810	1,900
Mexico	7,088	3,081	5,038	3,761
South America	1,300	2,200	1,300	508
Australia	300	1,100	643	105
British Columbia	9	6	2	11
Other countries	41	118	103	74
Total	13,788	15,205	13,098	6,359

And our exports previously have been:

	Flasks.		Flasks.
In 1869	24,415	In 1860	9,448
In 1868	44,506	In 1859	3,399
In 1867	28,853	In 1858	24,142
In 1866	30,287	In 1857	27,262
In 1865	42,469	In 1856	23,740
In 1864	36,927	In 1855	27,165
In 1863	26,014	In 1854	20,963
In 1862	33,747	In 1853	12,737
In 1861	35,995	In 1852	900

During the year 1873, the market has presented many unexpected features. The price opened in January at 90 cents, was advanced in February to 92½ cents, in March to 95 cents, at which figure it stood on the first of April, 1873, at which date the combination expired which had for a long time kept under one control the entire product of the three largely producing mines, viz., the New Almaden, the New Idria and the Redington. The sales had for some time been sharply up with the total production, and there was at that date no surplus stock whatever on either the home or any foreign markets. The parties who owned the New Idria mine were also the parties who enjoyed the combination contracts for so long a period, and they were of course desirous of making fresh contracts for a new term, whereby they could continue to enjoy the profits of handling the product of all these mines on a commission basis. The Redington Company, however, refused to make any such arrangement, preferring to handle their own products and realizing that there was no longer the least need of any combination to protect them from competition in price, but that, on the contrary, every flask of quicksilver would be needed for local consumption quite as soon as produced.

Thus from the 1st of April, 1873, there has been no combination whatever among the three large mines above mentioned, but the market has regulated itself by the laws of supply and demand, as in the case of any other commodity. The price continued 95 cents per pound until June 24, 1873, when it was raised to $1, advancing in August to $1.10 per pound, and still again on the 18th of November, 1873, to $1.20 per pound in gold, cash, at which figure it closes the year, with a demand for export considerably in excess of the ability of the market to supply. It is easy to see the causes which have led to this large advance, and impossible not to recognize their legitimacy. Briefly stated, the whole solution lies in the fact of the very large decline in the product of the New Almanden mine, which, in the years of its prime, used to produce fully 3,500 flasks per month, but which, during the year 1873, has not produced as much as 1,000 flasks per month, and, indeed, in the last half of the year has not averaged, it is said, 750 flasks per month. In the mean time, the New Idria and the Redington have no more than held their own, and all the newly opened mines together have not made a total product to exceed an average of 400 flasks per month for the whole year; the deficit of the production of the New Almaden being thus 2,500 flasks per month,

> there having been substantially no gain of product from either the New Idria or the Redington, and only a total gain from all the new mines together of not over 400 flasks. The market has heretofore been at least 2,100 flasks per month short of its supply in previous years, a decline of over one-half in available stock. The first effect of this was to cut off all shipments to China and Mexico, and these markets, which have heretofore drawn from California as much as 20,000 flasks per year, were forced to send to London for their supplies, where they met with a market only moderately well stocked, and totally unable to supply so large a demand thus suddenly precipitated upon it.

The same journal states that it is not thought possible to increase the yield of the Almaden mine in Spain, even in times of peace, so as to meet the increased demand in London; and it may be stopped altogether on account of the disturbances in Spain. It says that the New York market alone calls for from 500 to 600 flasks of quicksilver per month, and the home consumption on the Pacific coast is such that not more than 200 or 300 flasks per month can be spared for export to New York. Such being the facts with reference to the supply of quicksilver, now, when we consider the demand for consumption, we find that such has been the development of mining industry on this coast that our mills now consume fully 50 per cent. more than they did two years ago, and it is to-day a fact that the local requirements of the Pacific States and Territories for mining purposes are so nearly equal to our total present production of quicksilver as to leave none whatever to spare for foreign export. As to the probability of an increase in supply, the Herald says:

> It would appear from the best obtainable information that the New Almaden does not promise to yield as much as last year, and may not safely be counted on to produce over 750 flasks per month. The New Idria promises no increase, and cannot be estimated at over 750 flasks. The Redington mine, which has during the past year been unable to reduce all its ore, by reason of the partial giving out of its old furnaces, has for the past six months been constructing two new furnaces, on the Knox & Osborne Patent plan; and will, in the course of January, 1874, place them in operation. They have been very carefully constructed, at large expense; and are claimed to be by far the best quicksilver reduction works yet constructed. When in operation they may be counted on to increase the yield of the Redington mine from 350 flasks per month—its yield for the past year—to say 600 flasks per month; and this may be counted on as a permanent increase, as they have already mined, and on the surface 10,000 tons of ore, and the daily out-put of the mine is fully equal to the capacity of the new furnaces. The Redington will thus make good the deficit over last year's production of the New Almaden, so that the three principal mines together will produce the same aggregate as they did last year. This would still leave an unfilled requirement of at least 1,000 flasks, on the consumption figures before given, and this can only be made up by new mines coming into production.

The writer (Mr. Yale) has spoken with several gentlemen familiar with the quicksilver interests of the coast, and they agree that the view taken by the Herald on the subject is the correct one. The "monopoly" so long existing in this product exists no longer; and the price is regulated by the well known laws of supply and demand.

An attempt has been made this year to obtain reliable data as to the production of each quicksilver mine in California. The writer regrets to add that this attempt has been abortive, but better results are hoped for next year. One great difficulty in the way was that so many different deposits were found this year in widely separated localities in the State, of which there had been nothing but newspaper mention; it was difficult to obtain the names of parties in authority who could give reliable figures, and in numerous cases these parties when found refused to make the affairs of their mines public. Letters written to superintendents or owners were never answered, or, when answered, the information was declined, or the writer was referred to other parties who could not be found. One reason for this, in connection with the new mines, is, that the local newspapers had so systematically "puffed" certain "claims" that the owners did not like their mines to be compared with others more favored, since in most instances the mines are for sale. Indeed, it was found on close examination that only a small proportion of any of the new mines are producing at all; others are turning out a few flasks, while two or three give evidence of becoming some day very valuable. The majority of them, however, are hardly prospected, and do not as yet deserve the name of mines. Some work is doing on most of them, though the majority of the owners are slowly opening their claims so as to place them in a condition favorable for sale.

The following statement gives, as far as could be obtained, the amount of quicksilver yielded by producing mines during 1873: New Almaden, 11,042 flasks; New Idria, 7,600 flasks; Redington, 4,200 flasks; Great Western, 651 flasks; Manhattan, 621 flasks; Summet, 75 flasks; American, 128 flasks; Napa, 199 flasks; California, 995 flasks; Phœnix, 880 flasks; Washington, 197 flasks.

Among the important mines which have been producing, but from which no returns are obtainable, is the Saint John, near Vallejo. The Vallejo Chronicle says of it, in a late issue:

> The Saint John quicksilver mine has now been producing, since July 1, 1873, and is proving a mine of wealth to its proprietors. The average production of quicksilver from this mine, since the date given, has been 200 flasks per month, some months the yield reaching as high as 300 flasks, and then again falling to a much lower amount. In the Wilson drift—making the third level—which the workmen have recently been engaged in running, metal has been struck. Ore is also being still taken out in the Vallejo drift. The mine is now employing about sixty men.

The Lost Ledge in Napa County produced, with a retort, about 20 or 30 flasks; and the Sonoma mine has produced 50 flasks during the year. The Missouri, in Napa County, produced with a retort in December, 1873, and January, 1874, about 1[illegible] or 20 flasks of quicksilver, but nothing previous. The Sonoma or Thompson mine at Pine Flat completed its furnace in January, 1874, and cleared up about 50 flasks at the first run.

The Manhattan mine, spoken of above as having produced 621 flasks, has only run its furnace during the last eight months of 1873. The Oakville or Napa produced from June 21, 1872, to January 1, 1873, 180 flasks. From January 1, 1873, to June 1, 1873, it produced 199 flasks. The mine shut down in June, 1873, and is now in the bankrupt court.

The Panoche or Cerro Bonito mine in Fresno County will shortly be supplied with reducing works, when it will be placed on the list of producing mines. The Knox and Osborne furnace at the mine is nearly completed and will reduce 24 tons per day. The ore is reported to be very rich.

Among those mines which have produced little or nothing this year may be mentioned the Lake, in the county of the same name; the Keystone, in San Luis Obispo County; the Abbot, in Colusa County; the Yellow Jacket, Hasbrouck, Ida Clayton, Pine Mountain, Lodi, and Geyser, at Pine Flat; the Valley, Pioneer or Bell, Last Chance, and Guadeloupe.

Quite a number of other claims might be mentioned, which are now being prospected. Some of those spoken of are working with retorts, but until furnaces are supplied the product will be very small.

The Saint John mine is quite a promising one. The mine and works are located on the Wilson Hill ranch, five miles from Vallejo, Solano County, in the range of high hills that form a portion of the Coast Range. The hills of Sulphur Spring Valley were long since known to contain quicksilver. In the year 1852, Mr. John Neate first became convinced of the existence of valuable ores in that locality, and made the first exploration. In 1858, he placed before capitalists specimens of cinnabar taken therefrom. They discouraged the opening of any new quicksilver mine, stating as a reason that the supply was greater than the demand. Under these discouraging circumstances prospecting was continued on a small scale for several years until the appreciation of quicksilver and the increased demand for the use of California mines enlisted the assistance of San Francisco capitalists, through whose efforts several promising mines have been opened in the Coast Range counties north of San Francisco Bay. Among these is the Saint John quicksilver mine, which is thus described by the Vallejo Chronicle:

> This mine and works are located on the Wilson Hill ranch, five miles directly north of Vallejo, in the range of high hills that forms a portion of the Coast Range. The ledge runs southeast and northwest, near the summit of one of the highest hills in the range, and dips to the north at an angle of about forty degrees. It was opened by a drift 20 feet below the outcrop, developing a width of 30 feet for the ledge, with 15 per cent. ore all the way through. At the end of the tunnel or drift, or at the "wall," on the east side, the workmen have gone down with an incline for a distance of 50 feet; and it is in this latter excavation where the largest deposit of rich ore has been found. From the mouth of the incline, down, the rock grew richer, and the bottom of the incline shows a solid mass of 50 or 60 per cent. ore. The superintendent is running a tunnel to tap the ledge on a level 173 feet below the outcrop. At a distance of two or three hundred feet west of the location of the above-described ledge, near the summit, a little prospecting has been done, developing a vein 6 feet wide, containing a lead of very rich metal, 6 inches in width, with a foot and a half of paying ore on each side, which, when first discovered, was only the thickness of one's hand, growing wider as they went down upon it. The lode of this portion of the mine has been traced and explored for half a mile, and at intervals of 25 feet shows the outcrop of metal of exceedingly rich character.
>
> At the mouth of the tunnel is located the smelting works of the company. The furnace is constructed of brick, in a circular form, between 9 and 10 feet in diameter, and about 13 feet high. The largest diameter of this furnace inside is 4 feet and 6 inches; it has a depth of 12 feet; the chamber is "charged" by filling it with ore and coke—a layer of each, one above another—and its capacity is eight tons every twenty-four hours. There are five condensing chambers altogether, situated about 10 feet apart, connected by a long brick flue, each chamber gathering some quicksilver; but in the fifth chamber little, if any, is found, the vapor having condensed before reaching that point; the smoke then passes off into a chimney, thence into the atmosphere.

At the first week's run of this furnace 50 flasks of quicksilver were produced, and the mines have probably turned out about 200 flasks per month for the last six months of 1873. This statement may be too low, although it is made on the assertion of parties competent to judge. However, the Benicia Tribune, a paper published in the vicinity of the mine, places the production at 300 flasks per month. Definite information on this point was refused by the superintendent of the mine.

The Phœnix is the principal of the Pope Valley mines. This place is eighteen miles from Saint Helena, Napa County. The Phœnix is said to produce about 50 flasks per week out of about 125 tons of ore. Most of the good ore is taken from the "Antone spout," nearly at the end of the main tunnel. The deposit runs all the way from 3 to 18 feet in thickness. The mine has been successfully worked for over three years, and has a Knox & Osborne furnace, the second of the kind ever built. A No. 8 Blake pump is required to keep the mine free from water. The machinery consists of a 12-horse-power pumping-engine at the top of the shaft, and a 12-horse-power for driving the Root blower at the furnace. This mine produced, during six months of 1872, 1,047 flasks of quicksilver. It was discovered in 1861 by John Newman, but it was not until the spring of 1871 that operations were conducted systematically. Up to January, 1871, 960 flasks of quicksilver were produced. From April, 1871, to October of the same year, 764 flasks were produced, and this year, 880 flasks.

The Washington mine is also located in Pope Valley. The ore is all taken from a cut in the hillside, and as the mine is being worked on a lease, no systematic developments are carried on. It is said to turn out 30 flasks per month from 100 tons of ore, the extracting and reducing of which costs only $4 at the mine. No machinery is employed. The furnace is the same as those used at New Almaden, and a section of iron condensers attached. It is charged ten times a month, with ten tons for a charge. This mine produced, in 1872, 127 flasks, working on a small scale. It run eight months in 1873. As they use adobes they cannot work after the rains set in. It produced, in 1873, 197 flasks.

The Ætna mine, a combination of the Silver Bow, Valley and Pope mines, has a furnace of the Knox and Osborne type, but the production is as yet unimportant.

The Great Western mine, in Lake County, is another of the very promising mines now producing quicksilver. They have a 10-ton furnace, and are working 65 men at present writing. The mine produced, in October, 290 flasks; in November, 191 flasks, and in December, 170 flasks, or 651 in all, during the time the furnace has been running. The following description of the mine was written by Mr. Skidmore after a visit in August, 1873.

The Great Western Quicksilver Mine is situated on the east slope of the Saint Helena Range, at an elevation of 2,200 feet above sea-level and about 1,000 feet above Saint Helena Cañon—distant sixteen miles from Calistoga. The mineral-bearing matter has a width of from 30 to 50 feet, and consists of a serpentine and talcose formation, associated with chlorite and shales, the whole mass irregularly impregnated with cinnabar, and containing ores of various grades, from one per cent. to pure cinnabar. The ground has been explored for a length of 1,500 feet by numerous tunnels, and a large proportion proved to be mineralized to a profitable degree. The workings of the mine through the various tunnels, which attack the ore-body at right angles to its course, have satisfactorily demonstrated its continuity and richness for more than 1,000 feet in length and an average depth from "grass roots" to floor-sills of lower tunnels of 150 feet—leaving apparently the best ground under these floors to be developed by shafts.

The ore-body has been tapped by eight tunnels. Four of these—the upper tunnels—may be considered as mere prospecting tunnels, though available for the extraction of surface-ores. Of the four lower tunnels, the main adit, No. 8, attacks the deposit from the southeast side, running under a ridge 100 feet higher than its mouth, and connecting (when completed) by means of a main drift with three lower tunnels on the other side of the ridge. When this work is completed, the entire product of the mine will be run out through this tunnel, in cars, over a tramway nearly 1,000 feet in length, to the ore-chute, where it is dumped on the feed-floor of the furnace, 100 feet below, thereby saving handling and hauling of the ores.

Pending the completion of this work, the tunnels on the other side of the ridge are being vigorously driven on the ore-deposits, and a shaft is being sunk on No. 8 for a new level, and "raising" to surface is progressing. No extensive and rich chambers or deposits have as yet been struck. The entire mass is permeated with veins of cinnabar, alternately contracting and expanding, but showing the remarkable feature of a uniform and continuous widening with depth. In fact, in all the faces of the various drifts and tunnels, the faces look better on the floor than on the roof. This indicates that the present deposits are stringers or exflorescences of larger deposits. These stringers are sometimes mere seams, but are nowhere absent in any part of the works, and in some parts have an expansion of 5 to 10 feet.

The property was acquired a year since by a few shrewd capitalists of San Francisco at a cost of about one-tenth of what the same prospect would now command. They have quietly and steadily proceeded in its development, having expended some $50,000, and are now about to reap the reward of their perseverance and enterprise. But few except the owners have known of the existence of a property which at no distant day will compete in production with the New Almaden and Redington.

The furnace was built on the plans of Riotte and Luckhardt, and has a capacity of from ten to twelve tons per twenty-four hours. They are provided with double sets of condensers with capacity sufficient for running another furnace of equal size, which will no doubt soon be erected, as even now the ore-supply will exceed the facilities of reduction. The object of two sets of condensers is that one may cool while the other is in operation, thereby insuring continuous runs. The company own several hundred acres of well-timbered land, and are receiving wood at $2.50 per cord. Mr. Luckhardt estimates the cost of treatment of ores at from $1.25 to $1.50 per ton, and the loss of quicksilver at from 5 to 6 per cent. of the average assay of the ores. Under all these circumstances, taking into consideration cheapness of labor and fuel, and conveniences for extracting and delivering ore from so vast a deposit, it would seem that a fair profit may be made on 1 per cent. ore, and a large revenue derived, by the construction and operation of another furnace of equal capacity, even of this low grade of ore. However, there is no reason to suppose the average yield will run below 2½ per cent., and even 5 per cent. may be looked upon as reasonable. The extent of supply is practically unlimited for many years unless the reducing-machinery should be largely increased. The appliances of the mine are first class, and show the exercise of skill, experience, and judgment in planning and execution. This is manifest in the construction of furnaces, chutes, roads, and handling of water.

The Quicksilver Company, owning the New Almaden mine, in Santa Clara County, produced, during 1873, 11,042 flasks of quicksilver of 76½ pounds each, being an average monthly production of 920 flasks. The production for the several months was as follows:

	Flasks.		Flasks.
January	1,325	August	735
February	1,232	September	615
March	875	October	700
April	1,000	November	750
May	1,100	December	1,000
June	910		
July	800	Total	11,042

This product was disposed of as follows:

	Flasks.
Delivered D. O. Mills, under contract of sale which expired April 1, 1873	3,253
Delivered Thomas Bell, for sale on account of the company	7,663
On hand, December 31, 1873	126
Total	11,042

The earnings from all sources, as detailed in the manager's report, were $827,169.28. The expenditures were $398,666.01, showing a decrease as compared with the preceding year, while the outlay for prospecting and dead-work has been fully equal to that of former years.

After the expiration of the contract, (April 1, 1873,) for the sale of the product to Mr. D. O. Mills, at $50.50 per flask, the company entered into an agreement with Mr. Thomas Bell of San Francisco, to act as agent for the sale of the product for one year. It was considered fortunate that the old contract was got rid of at a time when, from natural causes, the price of quicksilver was considerably enhanced, thereby enabling the company to reap the benefit of a higher price. The first-mortgage bonded indebtedness of $500,000 in gold, due June 1, 1873, has all been paid and canceled. Through the extinguishment of this funded indebtedness the company is relieved of an annual interest charge of $35,000 in gold.

While the product of the mine has fallen off largely, as compared with preceding years, the financial condition of the company has materially improved. The surplus in cash, quicksilver, and ore, after paying the first-morgage debt and the interest due January 1, 1874, was $320,000. The second-mortgage bonds, amounting to $1,000,000, now constitute the only outstanding obligation.

The operations of the mines of New Almaden are shown in the report of Mr. Randall, the manager, for the year ending December 31, 1873, to have been as follows:

Earnings:	
From 3,253 flasks of quicksilver produced from January 1 to March 31, sold and delivered to D. O. Mills, esq., under contract of $50.50 per flask	$164,276 50
From 7,789 flasks of quicksilver produced from April 1 to December 31, as follows: Sales of 5,638 flasks through the agency of Thomas Bell, esq., at current market prices for account of the company	410,100 55
Advances on 2,025 flasks consigned to Thomas Bell, esq., for sale	101,250 00
Amount to be received over advances on 2,025 flasks, and value of 126 flasks at the mine, estimated	70,830 00
From rents and privileges	26,729 84
From miscellaneous sources	2,322 64
From ore account increased	51,659 75
Total	827,169 28
Expenses:	
Mine and hacienda pay-rolls	$317,573 69
Material and supplies consumed	56,244 29
Miscellaneous property	1,314 38
Taxes and miscellaneous expenses	23,533 65
Net earnings for 1873	428,503 27
Total	827,169 28

Showing, as compared with 1872, a decrease in gross earnings of $82,249.07; in expenses of $58,993.17; and in net earnings of $23,255.90.

Under the present arrangement for sale of quicksilver, the company receives on its monthly product an advance of $50 per flask, and subsequent settlements at market rates. Half the quicksilver is now delivered in irregular flasks, containing 67 pounds, thus making available 20,000 flasks, which have been stored at the works for many years as unserviceable. The quicksilver which is intended for sale in Nevada and New York is delivered to Mr. Bell at San José instead of San Francisco, thus saving freight and charges amounting to 25 cents per flask. The advance in market price has been rapid. In May it was 95 cents per pound; in June, $1; in August, $1.10; and in November and December, $1.20; while the price in London for quicksilver from Spanish Almaden was £20 per flask, or $1.25 per pound.

Mr. Randall gives the following interesting details of operations:

The mine pay-rolls are classified as follows:

Ore paid miners by the carga	$101,552 00
Ore cleaning by the carga	9,236 98
Terrero	16,424 77
Tierras from the dump and mine	10,460 42
Prospecting, miners by the day	12,878 00
Yardage	71,684 19
Timbermen and miners by the day	13,067 50
Tramming	17,875 83
Foremen	5,245 00
Laborers and skilled labor	15,524 12
Wagon transportation	1,979 37
Total	275,928 18

The price paid for mine ore averaged $5.18 per carga of 300 pounds, and the cost for cleaning it was 47 cents per carga. The terrero or lowest grade ore, picked from the dump, and the tierras, or fine screenings, cost respectively an average of $1.84, and 30 cents per carga. For ore of all qualities and grades the cost per carga was $3.04, in which cost are included all expenditures on mine pay-rolls. The dead-work and prospecting equaled an average cost of $1.07 per carga.

The hacienda pay-rolls amounted to $41,645.51, of which the expenditures were for—

General account, including repairs	$29,647 08
Operation of railroad	2,789 19
Operation of furnaces	9,209 24
Total	41,645 51

The average number of furnaces in operation was 5½, and the number of charges fired and roasted was 185, the average quantity of ore in each charge being 93,678 pounds, making an aggregate of 17,330,375 pounds.

The furnaces consumed 2,363 cords of wood, at an average cost per charge of $76.64, or a cost per carga of 25 cents, or $1.28 per flask of quicksilver produced; coke, charcoal, and coal were used to a limited extent; and adding their cost to the value of wood consumed, the total average cost per carga for fuel is 26 cents. Taking the totals of the hacienda pay-rolls and the value of wood consumed, the average cost per charge for roasting ore was $301.75; per carga, 97 cents, and per flask of quicksilver produced, $5.06.

The following is a comparison of these costs with those for the same purposes in 1872:

	1872.	1873.	1873.
Wood, average cost per charge	$78.16.	$76.64.	$1.52 decrease.
Wood, average cost per carga	0.22.	0.25.	0.03 increase.
Wood, average cost per flask	0.86.	1.28.	0.42 increase.
Wood and pay-rolls, cost per charge	242.05.	301.75.	59.70 increase.
Wood and pay-rolls, cost per carga	0.68.	0.97.	0.29 increase.
Wood and pay-rolls, cost per flask	2.67.	5.06.	2.39 increase.

The low grades of ores reduced account for the increased cost per flask of quicksilver produced, and the same cause, with the fact that all current expenses for repairs are included in pay-rolls, instead of being made a separate charge, as was done last year, explains the increase shown for pay-rolls and wood.

The cost of 11,402 flasks of quicksilver was $347,006.26, or $31.42 per flask, being $6.78 more than the average cost in 1872.

The production of mine ore was 19,595½ cargas of 300 pounds, a monthly average of 1,633 cargas. Of this quantity there was produced from the—

	Cargas.
Old mine	17,544
San Francisco	349½
Outside mines	1,702
Total	19,595½

There was gathered, moreover, from the dumps at the old and new Planillas 8,909¼ cargas of terrero, and from the dumps and the mine 62.176 cargas of tierras. The aggregate production of crude material was thus: 90,680¾ cargas, or 13,602$\frac{113}{1000}$ tons, an increase of 19,234¼ cargas over the previous year. This increase is in low-grade ore, averaging a yield of 2 per cent. of quicksilver, and requiring to be made into adobes or sun-dried bricks before roasting.

The mine at all points has been and is poor; and only by untiring exertion has it been possible to keep the furnaces even partially supplied with ore. Both extraction and prospecting have been pushed with the utmost energy, 9,233 feet of tunnels, drifts, cross-cuts, and shafts having been opened during the year, at an average cost of $23.29 per running yard, for prospecting or communications. The total expenditure for dead-work, including timbering, was $97,629.69. The results have proved, however, less satisfactory than those of 1871 and 1872; and the prospects of further developments are not at present specially encouraging. A discovery of rich ore, made in April, 1873, eventuated in disappointment, the size of the body being limited.

The product of this property during the period of 21 years and three months, ending December 31, 1873, was as follows:

New Almaden mine,	573,150 flasks, or	43,845,975 pounds.
Enriquetta,	10,571 flasks, or	808,681 pounds.
Total	583,721 flasks, or	44,654,656 pounds.

The following statement shows the product of all the furnaces for 1873:

Months.	Number of charges.	Class and quantity of ore.		Total quantity of ore.	Yield of quicksilver.		
		Granza.	Tierras.		Per cent. average.	True per cent. average.*	Number of flasks.
		Pounds.	*Pounds.*	*Pounds.*			
January	17	1,044,000	514,000	1,558,000	6.50	8.72	1,325
February	16	805,000	609,000	1,414,000	6.67	10.19	1,232
March	15	609,000	629,000	1,238,000	5.40	8.92	875
April	15	794,000	569,000	1,363,000	5.61	8.20	1,000
May	13	715,950	637,000	1,352,950	6.22	9.97	1,100
June	15	692,700	689,000	1,381,700	5.04	8.06	910
July	15	560,250	855,000	1,415,250	4.32	7.87	800
August	17	602,400	990,000	1,592,400	3.59	6.05	735
September	16	630,150	890,000	1,520,150	3.09	4.66	615
October	18	638,925	1,035,000	1,673,925	3.19	5.15	700
November	15	656,000	788,000	1,444,000	3.97	6.34	750
December	13	744,000	633,000	1,377,000	5.56	8.58	1,000
Total	185	8,492,375	8,838,000	17.330,375	4.87	7.86	11,042

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* This is the percentage of quicksilver in the ore, aside from the tierras; the latter averages steadily about 2 per cent.

The annual production since July, 1850, will be seen by the following table:

Dates.	Flasks.	Pounds.
July, 1850, to June, 1851	23,875	1,826,437
July, 1851, to June, 1852	19,921	1,523,956
July, 1852, to June, 1853	18,035	1,379,677
July, 1853, to June, 1854	26,325	2,013,862
July, 1854, to June, 1855	31,860	2,437,290
July, 1855, to June, 1856	28,183	2,155,999
July, 1856, to June, 1857	26,002	1,989,153
July, 1857, to June, 1858	29,347	1,245,045
July, 1858, to October, 1858	10,588	809,962
February, 1861, to January, 1862	34.765	2,659,522
February, 1862, to January, 1863	40,391	3,089,911
February, 1863, to August, 1863	19,564	1,496,646
November, 1863, to December, 1864	46,216	3,535,524
January, 1865, to December, 1865	47,194	3,610,341
January, 1866, to December, 1866	35,150	2,688,975
January, 1867, to December, 1867	24,461	1,871,266
In year 1868	25,628	1,960,542
In year 1869	16,898	1,292,697
In year 1870	14,000	1,071,000
In year 1871	18,763	1,435,369
In year 1872	17,753	1,358,104
In year 1873	12,000	918,000
Total	566,929	35,369,298

This table was compiled by Mr. Cronise for the "natural wealth of California," up to 1867, and the writer has added the product of each year since then, to make up the sum total. It is interesting as showing the immense product of one good producing mine.

The New Idria mine in Fresno County, which produced 7,600 flasks this year, is one of the more important mines of the State. Among the mines owned by the New Idria Company are the Idria, San Carlos, Aurora, Molino, Washington, Benada, and Victorener. The largest amount of work has been done on the Idria proper. This mine has been producing constantly since 1857. The underground work upon it is said to measure four miles. This year, very heavy machinery has been erected for the purpose of sinking 500 or 600 feet deeper.

The Rattle-snake mine is a peculiar deposit, containing native quicksilver. It is located in Sonoma County. Two cuts have been made in the mountain, from both of which tunnels have been run. Near the surface they struck a mass of cinnabar and vein-matter holding free quicksilver. Both the cinnabar and vein-matter are exceedingly rich. The free metal follows the blows of the pick and trickles down the sides in globules. A gentleman who visited the mine recently states that he saw dipped from a hole in the floor, with a shovel, a mass of blue clay, some water, and a greater proportion of quicksilver than either. He saw an oblong piece of cinnabar ore, not so large as a bag of shot, which weighed thirty pounds; it was valued at $25, there being in it only sufficient foreign matter to hold the mass together. A number of specimens of this kind were placed in a sack, and after it was lifted up there was beneath it a pool of metal. All the work done in this mine as yet has been with the aid of old-fashioned rockers instead of furnaces. The matter from which it comes is a soft, gray rock, impregnated with mercury globules, which are easily shaken together in the hand.

Quicksilver is known to exist in the Coast range at different points from Napa to San Bernardino. A deposit has recently been found in the latter county, but as yet has hardly been prospected. The Fresno County mines are more rich than numerous, the Idria being the principal one. The Cerro Bonito, before mentioned, is said to be a very promising mine, and will, no doubt, shortly become a good producing mine. The Winter's mine, in Monterey County, is now being worked, but as yet is producing nothing. Several other small claims are in like condition in that county.

Quicksilver was first discovered in San Luis Obispo County in 1863, and the mine was called the Sierra. The San Pedro, adjoining it, was soon discovered, and then, a short distance from the two, was found the Josephine. This was purchased by capitalists, and some $100,000 expended upon it. A handsome furnace was erected and commodious quarters for the men. This mine is now being worked on a small scale. The Libertad mine is on the same ground formerly owned by the Sierra and San Pedro mines. Work has been temporarily discontinued on this claim on account of water. The Quien Sabe, in this county, has lately struck a quantity of rich ore, and the owners intend shortly to erect a furnace. The Pine Mountain also has good ore, but has produced nothing as yet. The Keystone mine, which was bought by English capitalists, has produced nothing this year. Several other mines are in the vicinity, none of which have produced this year, for various reasons, the principal of which is want of capital. There are also several mines in Colusa County, prominent among which are the Abbot, Buckeye and Chapin. The veins already opened are doing well, and, with imperfect works, have more than paid expenses. At Sulphur Springs, where most of the cinnabar ore in the county is found, are several good mines. Several of these have been producing small quantities of quicksilver by the aid of retorts. The shipments from this locality are stated by the freight-agent to be about ten flasks per week.

Santa Clara County contains the far-famed New Almaden mine. Sonoma, Napa and Solano Counties contain large areas where cinnabar has been found and many good mines will no doubt soon be developed there. This year there has been little real mining done on the majority of the claims, most of them being only as yet partially prospected.

The cinnabar ore occurs at intervals throughout the entire length of Passa County, the area covered by it in a general way being not less than forty or fifty square miles. A correspondent of the Bulletin, in speaking of the mines of this county, says:

> The most productive district has for its center Mount Saint Helena, an irregular volcanic cone, situated in the northern part of the county, and rising abruptly on every side to a height of 3,500 feet. Scattered throughout the foot-hills that encircle, and the lower ranges that flank, this mountain, this cinnabar field reaches north and east into Lake and westerly into Sonoma County. Here more than a hundred company-claims have already been taken up, while the work of prospecting is still actively going on. Some of these claims have a very good and others but an indifferent show of surface-ore. In most cases, however, the croppings or top-deposits are rich, and often very extensive. Upon twenty-five or thirty claims a good deal, and upon about an equal number a moderate amount, of work has been done, the balance being held for speculation, with only enough work performed to keep possession under the local law. In some instances the claimants have not the means to open their grounds, and would give parties willing to undertake the work a liberal interest for developing them. Several companies have a large force of men employed, and have expended as much as fifteen or twenty thousand dollars, and in a few instances a good deal more, in opening up and improving their mines. The mode of exploration is by open cuts, shafts, and tunnels, the improvements consisting mainly of steam-engines for hoisting, pumping, and blast purposes, with furnaces, retorts, roads, buildings, &c. Most of the furnaces erected here are of the Knox & Osborne patent, which seems to have a preference over all others. In some cases the miners have recourse to a very rude and simple style of furnace as a makeshift to get out a few flasks of quicksilver to help keep down preliminary expenses, this commodity being now of as ready sale as gold bars themselves. This metal occurs here to some extent in a free state, though generally combined with sulphur and other minerals, in the form of an ore. Where found in any considerable quantity in a free state, it goes a long way toward defraying the cost of development, the miners sometimes collecting in a single claim as much as forty, and even sixty and a hundred, pounds daily.
>
> The ores in this vicinity, though mostly obtained thus far from near the surface, have

yielded from 2 to 6 per cent. of metal—averaging, perhaps, 4 per cent. In view of their abundance, and the small cost at which they can be mined and reduced, even 1 per cent. ore would leave fair margins for profit. Mining, hauling, and reduction can be done here at a cost of $5 or $6 per ton, the country about producing the staples of subsistence in abundance, while wood and water are everywhere in good supply. Under conditions so favorable there can be little question but the production of quicksilver will be soon increased to a degree that will work a material reduction of prices, however much the consumption of this article may meantime be extended.

Some prospecting for quicksilver has also been done in Trinity County on mines discovered in the fall of 1872. One of the claims, now owned by San Francisco capitalists, has recently been worked, and numerous other claims are being prospected by parties who are developing them by their own labor. Cinnabar is said to have been found in small quantities this year in Humboldt County, Nevada. It is also stated that it exists in the southeast part of Nevada. In referring to this the Pioche Record says:

> The Sevich Indians inhabit that part of the Colorado Valley that lies between the mouth of the Rio Virgin and the Big Cañon—a region of country believed to be rich in minerals, but which has been but very little prospected. The Seviches use a bright red paint, and trade it to neighboring tribes, which is believed to be genuine photosulphide of mercury or cinnabar. Believing the Piutes had just received their annuities, the Seviches recently visited their camps on the Muddy, with large quantities of it, intending to "swap" it for some of the gim-cracks they supposed the Piutes would be possessed of. Some prospectors, who happened along at the time, examined the natural paint and pronounced it identical with the vermilion found in the New Almaden quicksilver mine in California. The early Spaniards were led to that famous mine by Indians, who had long used the cinnabar to paint their faces and robes, it being to them a source of great wealth, as the Columbia Indians and all the intervening tribes were wont to come down and traffic for it. The Seviches, it seems, are using their deposits to like advantage, as the Piutes and Mohaves report their ancestors, as far back as their traditions reach, have obtained their paint of the Seviches. Quicksilver mines on the Colorado, if as extensive as those of California and Spain, would be a source of great wealth to individuals and to the country. Hundreds of thousands of dollars are sent out of Nevada annually for quicksilver. The Seviches might be induced, if approached in the right way, to disclose the locality of their deposits.

COAL.

The coal-measures of California, which have been extensively worked, are found almost entirely in the one county of Contra Costa, on the east side of San Francisco Bay. In this county are the Mount Diablo coal-mines, comprising the Black Diamond, Eureka, Pittsburgh, Union, and Central. The formation is tertiary, and the coal is entirely lignite. Although excellent for steaming purposes, for which it is chiefly used, it is of no use for smelting.* The coal contains quite large quantities of sulphur, and also weathers very rapidly on being exposed to the influence of the atmosphere. It is interstratified with sand-rock and shale. In some of the mines the roof consists of a mixture of the two, called by the men "bony," and, in such a case, there is some difficulty in supporting the roof. The average dip is 30°, and the strike is about northwest. The Mount Diablo coal is used to a very great extent for steaming; but in order to get good results the firing has to be not only very frequent but very light. When firing every ten or fifteen minutes, the flame is clear and good, and, as the coal is scattered on, the flame bursts out almost instantaneously. When, however, the fires are in the slightest degree crowded, large quantities of smoke are produced; and it takes but very little crowding to smother the fire altogether. The extreme ease with which the coal is weathered, and the fine state in which it is commonly used, necessitate the employment of grate-bars of a peculiar kind. These are either very close-ribbed, or else simply perforated with a number of small holes, through which the draft passes. One of the difficulties attending the use of Mount Diablo coal is the fact that the tubes of the boilers get very much clogged with it, and therefore have to be often cleaned out. The straight grate-bars also clog with this coal, and the fireman has to use his slice-bar liberally. Results obtained by the Oregon Steamship Company show, however, that it is a very good coal for steaming purposes. On that line low-pressure engines are used exclusively, and carry from 20 to 25 pounds of steam. Through the kindness of Mr. W. A. Phillips, the superintendent of the company, I am enabled to give the following facts and figures:

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* That is, if burned in the furnace containing the ores to be smelted. When burned in a producer, it will, of course, like any other fuel, give high temperature in a Siemens regenerative furnace.—R. W. R.

From the reports of the engineers it appears that the ash amounts to an average of 12 to 15 per cent., and that when the fires are apparently dead a little coal will bring them up again.

The following table, prepared by him, will show the relative value of the Mount Diablo coal and the Sidney (Australian) anthracite:

SIDNEY.		MOUNT DIABLO.	
Eighty tons, at $10.50	$840	One hundred tons, at $8	$800
Cartage, at 25 cents	20	Cartage, at 25 cents	25
Coaling ship, at 30 cents	24	Coaling ship, at 30 cents	30
Wharfage, at 10 cents	8	Wharfage, at 10 cents	10
	892		865

Eighty tons of Sidney anthracite are required to equal the effect of 100 tons of Mount Diablo, showing for the same work a difference of $27 in favor of the latter. In the opinion of Mr. Phillips, the best of the Mount Diablo coal is the Black Diamond, and the Pittsburgh next.

On some of the steamers plying on the bay and rivers of the State 200 and 250 pounds pressure is carried, but in these cases the firing must be repeated at least as often as every ten minutes.

The Scientific Press of the 28th of December, 1872, reports that it took 2,600 pounds of Mount Diablo coal to equal one cord of standard oak wood in the Government experiments. In the same article is mentioned the fact that some of the coal took fire spontaneously from the presence of sulphur. In neither case is the mine mentioned from which the coal was taken.

The total yield of the Mount Diablo coal-mines is given a page or two farther on. The yield of the principal mines since 1868 is shown separately in the following table:

Year.	Black Diamond.	Eureka.	Pittsburgh.	Union.	Central.
1869	78,361	16,924	27,756	17,756	4,729
1870	69,855	10,246	23,910	20,563	5,055
1871	73,544	18,194	22,339	17,208	4,000
1872	100,071	16,831	26,309	21,493	....
1873, (six months)	46,665	4,077	14,440	10,007	....
Total	368,496	66,272	114,754	86,726	13,784
Monthly in 1873.					
January	8,701	986	2,571	2,035	....
February	6,193	1,455	1,298	1,498	....
March	7,119	1,438	1,797	1,776	....
April	7,074	198	2,507	1,602	....
May	9,245	Worked out	3,167	1,551	....
June	8,333	....	3,100	1,545	....
Total for six months	46,665	4,077	14,440	10,007	....

It will be noticed that, of the mines named, the yield of the Pittsburgh alone for the six months promises an advance on that of last year; that of the Union will remain about the same, and the Black Diamond will fall below last year. During the first six months of this year the Black Diamond Company has been doing almost entirely dead work, and preparing to open the mine very completely at the end of about six months more.

Mr. T. M. Balch, of San Francisco, who has recently visited the Black Diamond Mine, of Contra Costa County, probably the most thoroughly developed coal-mine in California, furnishes the following description of its condition and works:

> The Black Diamond being the largest and also the most completely developed of all the Mount Diablo mines, a short description may be of interest. In the mine there are two seams now being worked, the "Black Diamond" and the "Clark." To get down to these there are at present two slopes and one tunnel, beside the new pit, not yet finished. Leading from the foot of one of these slopes is a third, which goes on down to the lower level of the Mount Hope seam. The Clark and Mount Hope are the same; but there were originally separate claims for the two parts of the seam, and when the present company bought them the original names were retained. Each of the slopes is furnished with hoisting-engines, single, and working two reels on the same shaft, lowering and hoisting at the same time. There are six plain tubular boilers, four of which are working all the time, while two are being cleaned. These supply all the steam that is needed both by the engines and pumps. Inside the mine there are four pumps, two working and two spare, of the "Cameron special" pattern, 3-foot stroke; diameter of steam cylinder 18 inches, water cylinder 12 inches, and throwing 36 gallons per double stroke. At present they are working about 18 strokes per minute, although they have been run up as high as 46. There are 800 feet each of steam and water pipes in the mine. The pumping is only done in the Mount Hope, it draining all the others. There are two furnaces, one in the Black Diamond, the other in the Clark, and by the aid of these the ventilation is so good that the men work entirely with the ordinary open lamp, instead of the "Davy." The gangways of the Black Diamond vein are three, the upper 4,000 feet long; 200 feet below this the counter, about 3,700 feet long; and 300 feet below this again the lower, of about the same length. This is on the west side. On the east side the lower gangway runs out 3,000 feet; all of which was cut before breasting up for coal at all.
>
> Leaving the Black Diamond and going to the Clark, we strike the main gangway, 5,000 feet long, 300 feet above which comes the counter of this mine, about the same length as the main; 250 feet below this is the counter of the Mount Hope, 4,000 feet; and 250 feet down brings us to the upper gangway of this mine, 4,900 feet long, and which is 400 feet above the lower gangway, 2,240 feet long. This 2,240 feet is on the West side, but there is 700 feet more on the East in this gangway. There are, therefore, 32,540 feet of gangway in these claims. The Black Diamond vein has for roof and floor shale, slate, and "bony." The Clark and Mount Hope, namely, the Clark vein, have sandstone almost entirely.
>
> The new hoisting-engines which have just been put up at the new shaft, but which are not working as yet, are a novelty in some respects, at least on this continent. In choosing the style of engine, the president of the company, Mr. Cornwell, took the report of the committee of the Paris Exposition on mining machinery, and from it got the pattern of hoisting works, to which they gave the greatest degree of approval.
>
> After making some changes to suit their particular circumstances, the engines were built by the Pacific Iron Works of San Francisco. They consist of a pair of right and left horizontal engines 17 feet apart and resting on pillars of solid brick masonry 5 feet wide at top, 9 feet at bottom, 35 long at top, and 43 at bottom, and 14 feet high. Ten feet down from the top of each pillar is a duplicate bed-plate, fastened to the ones above by 22¼-inch bolts. The cylinders are five feet stroke and 25 inches diameter At the end of each cylinder are slides on which rests move, and to these rests the ends of the piston-rods are keyed, thereby preventing any wear to the cylinders by the pistons. The cranks are secured at right angles to each other on the shaft, and on this shaft are the two reels and the fly-wheel, the weight of which is eight tons. The engines are fitted with puppet-valves and "cross variable cut-off," which is worked by the engineer. They also have, in addition to the regular brake, a steam-brake under the control of the engineer; and also automatically attached to the pulleys over the pit-head, so that, should at any time the cage be overdrawn, the brake would be thrown into motion and the engines stopped; it being quite sufficient to stop them even with steam on full length of stroke. The spring-bearings rest on a pillar of masonry, as to the steam-brake throttle-valve, &c. The reels are to carry 600 feet of wire-rope each, the rope being flat, one-inch thick and five wide. The cages are double-decked and provided with

safety hooks and clutches, everything about them being made of wrought iron. The pit-head is 45 feet high, made of strongest kind of timber and braced with iron rods in every direction, and rests on six columns of masonry. The pit is separated into three divisions, two 5 feet 8 inches by 9 feet in the clear for the cages, and one 5 feet by 9, for the ladders, pipes, pump-rods, &c. It is timbered with 14-inch timber from top to bottom, and outside the timber planked with red-wood plank, 3 inches thick. It is now 430 feet from the landing to the bottom, which is on a level with Mount Hope lower gangway. From the foot of this they are also running a tunnel which will tap the Black Diamond vein, so that when it is finished they will be able to run out all the coal taken out by the mine through this one shaft. They expect to get out about a thousand tons a day. The new hoisting-works of this company are considered by competent judges to be the most complete at this time in the State, or indeed on the coast.

The Commercial Herald, of San Francisco, gives in its annual review for 1873 the following table of receipts of coal in San Francisco from mines on the Pacific coast for the past fourteen years:

Years.	Mount Diablo.	Coos Bay.	Bellingham Bay.	Vancouver Island.	Seattle.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1860		3,145	5,590	6,655	
1861	6,620	4,630	10,055	6,475	
1862	23,400	2,815	10,050	8,870	
1863	43,200	1,185	7,750	5,745	
1864	50,700	1,200	11,845	12,785	
1865	60,530	1,500	14,446	18,181	
1866	84,020	2,120	11,380	10,852	
1867	109,490	5,415	8,899	14,829	
1868	132,537	10,524	13,866	23,348	
1869	148,722	14,824	20,552	14,880	
1870	129,761	29,567	14,355	12,640	
1871	133,485	28,690	20,284	15,621	4,918
1872	177,232	32,562	4,100	26,008	14,830
1873	171,741	38,066	21,211	31,435	13,572

The following table, from the same source, shows the imports from all quarters:

	1872.	1873.	Increase.	Decrease.
FOREIGN.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Australian	115,332	96,435		18,897
English	29,190	52,616	23,426	
Vancouver	26,008	31,435	5,427	
Chili	3,682	400		3,282
Japan		50	50	
EASTERN.				
Anthracite	19,618	18,295		1,323
Cumberland	10,051	8,857		1,194
DOMESTIC.				
Mount Diablo	177,232	171,741		5,491
Coos Bay	32,562	38,066	5,504	
Bellingham Bay	4,100	21,211	17,111	
Seattle	14,830	13,572		1,258
Rocky Mountain	1,862	1,904	42	
Total	434,467	454,582	51,560	31,445

	1869.	1870.	1871.	1872.	1873.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Foreign	109,000	135,168	113,483	174,212	180,936	712,799
Eastern	38,600	30,820	13,291	29,669	27,152	139,532
Domestic	184,100	167,183	188,420	230,586	246,494	1,016,783
Total	331,700	333,171	315,194	434,467	454,582	1,869,114

The Herald contains the following remarks relative to Pacific-coast coal-mines:

> The receipts from Bellingham Bay for 1873 were 21,211 tons, against 4,100 tons in 1872, and 20,284 tons in 1871. The cause of the great falling off in 1872 was by reason of a fire in the mine, which stopped operations. The mine is now producing largely, and the quality of the coal for household purposes is superior, not to say cheaper in price, than any other sold in the market suited to the use of families. Price, $8.50. The arrivals from Coos Bay are 38,066 tons against 32,562 tons the year previous. This exhibit is greater than ever before. The shipments from the Eastport mine, at Coos Bay, in 1873, have averaged about 2,000 tons per month, and would have been increased had it not been for the unprecedentedly large quantities of foreign coals on the market, and the consequent low prices prevailing. During the past season a drain-tunnel of 1,700 feet has been cut in the mine, and many other permanent improvements made, whereby the out-put can at any time be increased to a large amount. The coal has found a ready sale at prices ranging from $10 to $12 during the year. The California Mount Diablo mines produced, in 1873, 171,741 tons; the Black Diamond, 104,106 tons; Eureka mine, 4,098 tons; Pittsburgh mine, 32,363 tons; Union, 22,600; Central mine, 8,578 tons. This bituminous coal is very generally used for steam purposes by local factories and inland steamers—even the refuse, fine screenings, is preferred by our largest factories and mills. The price of coarse is $8.25; fine screenings, $6.25. The Vancouver Island mines—Nanaimo—have shipped us 31,435 tons in 1873, showing an increase of more than 5,000 tons over 1872.

During the summer and fall of 1873, extensive bodies of lignite have been discovered in the foot-hills of the Sierras, on the eastern rim of the Sacramento Valley. Of these new discoveries, the most notable are in Jackson and Ione Valleys, Amador County, and in the vicinity of Lincoln, Placer County. These deposits are now in process of development, and their producing capacity will be fully tested during the present year. In Amador County the product of the foot-hill mines finds a ready sale at the mines on the mother lode, in the vicinity of Sutter Creek, where it is delivered at $4 per ton. A narrow-gauge railroad is now in contemplation between Stockton and Ione Valley, which will terminate near these beds of coal, thereby affording another market for the extensive beds of lignite in the foot-hills of Amador and adjoining counties. Deposits of coal are also known in Mendocino County, on the Middle Eel River, concerning which I shall be able to speak more precisely in my next report.

IRON.

The iron ores of California, as at present known, comprise hematites, limonites, and magnetites. Of the latter, California probably possesses immense deposits; but, being chiefly in the form of sand, they have never been worked. Their treatment by the Catalan method would be too expensive. They are found along the coast, as well as in the old sea-beaches in the interior. The hematites, both red and brown, (limonite,) of which the latter is the more plentiful, exist in enormous quantities in the counties of Plumas and Sierra. I am indebted to Mr. Brunner, superintendent of the Pacific Rolling Mills, for information concerning them. The only way in which the ores of California have been worked has been in the puddling furnaces of that company, there being no blast furnace in the State.

The chief use hitherto made of these ores has been to line the puddling furnaces, for which purpose some of them answer very well. The average yield of metal seems to be from forty-eight to fifty-three per cent. The difficulty in the way of a blast-furnace is the want of suitable coal. Although there are plenty of places where there is enough timber to make charcoal, there is apparently some difficulty in finding a bed of ore and timber close together. The experiments made in Oregon with the blast-furnace are said to show that, while in the East it requires the growth of six thousand acres of land to one furnace, in this country there must be eight thousand. Another difficulty in this State is the curious manner in which the ore-beds are contorted and broken up. The consequent number of faults makes mining very hazardous, since at any moment the miners may strike faults which will give them weeks of dead work.

The most extensive iron deposits known to exist within the limits of the State are those of the Sierra Iron and Mining Company. This property consists of iron and timber land in Plumas and Sierra Counties, near the eastern boundary-line of California; so situated to each other and to neighboring markets as to present the elements of a large and successful iron business.

The property of the company embraces a tract of 1,920 acres, claimed and held under local and State mining laws, pending proceedings for a United States patent; a claim comprising 5,600 acres of timber-land, situated in Mohawk Valley, within nine miles of the iron-ore bank, and about 2,500 feet lower in altitude.

I am indebted to Mr. James D. Hague, M. E., for the privilege of making a few extracts from a joint report made by himself and Mr. Clarence King, descriptive of this property:

> *Geological formation.*—The deposits of iron occur along a line bearing about north-northwest and south-southwest, in an equally directed belt of a certain class of metamorphic rocks, which is bounded east by granite, and west by metamorphic slate, and extends over four miles in width by several times this amount in length. It consists of hard rocks, distinguished by their siliceous and often ferruginous character, the constant presence of hornblende and chlorite as ingredient parts, and a great variety of stratification, which frequently is missing; it is well known as one of the richest gold-bearing belts in California, the veins being among the widest and most continuous which are worked to profit, and containing the precious metal remarkably equally dispersed, while the slate to the west, and the granite to the east, contain generally but poor and barren veins of quartz. Some gold-bearing veins are being worked profitably close to the deposits of iron-ore.
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> Parallel to the western boundary line of this belt, and a little distant from it, runs a series of small bluffs of yellow crystalline limestone, bounded on both sides by chloritic slate. The iron-ore accompanies this limestone in the shape of abrupt deposits of varying extent. Neither the limestone nor the iron-ore forms a continuous band, but either of them occurs in apparently disconnected bodies along one and the same well-defined line It therefore happens that the iron-ore at places is connected with the lime, while at others it is imbedded in, and forms part of, the chloritic slate. The shape of these deposits corresponds to what is called in German, *Erzstock*.
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> *The ore-deposits.*—The tract containing the iron-ore deposits is situated in Sierra County, near the headwaters of the North and Middle Forks of the North Yuba River, a stream flowing down the west side of the Sierra Nevada Range. A portion of the deposits appears in Gold Valley, and a portion in Spencer's ravine. The latter is separated by a single broad, rounded ridge from a branch of Jamieson Creek, a considerable stream flowing into Feather River, not far from the Mohawk Valley timber-tracts.
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> *Character of the ore.*—These mines can boast of the best quality of iron-ore which is known to exist. They consist altogether of magnetic iron-ore, the same from which the celebrated Swedish and Russian iron is manufactured. Practically, the ore occurs at these mines in three different conditions:
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> First. Massive magnetic iron-ore of remarkable purity; it is very fine grained, and reminds one of the appearance of steel. Its yield in iron is from 60 to 65 per cent.

Second. A mixture of pure magnetic-iron ore with carbonate of lime. The latter is in the state of calcspar, or marble, and fills cavities in the former; if not present in too large quantity, it rather improves the ore by serving as a flux. Different bodies present different gradations of the combination of the two substances, from pure magnetic iron to limestone, with an admixture of the same, the proportion of iron-ore being occasionally as low as one-fifth in bulk, and one-third in weight. Such qualities, by being added to others, will form an eminently good flux. The ores of this second class may in general be considered as rich as those of the first class, as the latter have necessarily to be mixed with the only impurity of the former in order to be prepared for smelting.

Third. Chloritic and talcose slate, containing innumerable crystals of magnetic iron, the relative bulk of which to that of other mineral substances varies from 3 : 1 to ½ : 1 and less. The impurities are the same which are frequently combined with magnetic iron, principally the silicates of alumina, magnesia and protoxide of iron. As magnesia is present in the form of silicates, (varieties of hornblende, especially asbestos and some talc,) it will not be injurious to smelting. None of those substances which, by the smallest admixture, deteriorate the quality of iron, such as phosphorus or sulphur, appear to be present. The yield of iron of those ores of this third class, which form the bulk of the deposits, will not be short of 50 per cent.

Mode of occurrence.—From the northernmost outcrop in Spencer's ravine the iron-deposits appear as an irregular detached chain of bodies, trending south-southeast across the Four Hill Valley, and re-appearing over a low divide on approximately the same line, a mile farther south in Gold Valley.

Following, as they do, the strike of the inclosing rocks, it is probable that these isolated outcrops represent a single zone of lenticular deposits of ore, and that those portions visible above ground are but a small fraction of the whole mass. While it is not to be expected that there is anything like a continuous vein of ore along the whole length of the line, yet it is fair and reasonable to expect greater quantities under the surface than appear above it. Accompanying the ore-bodies, throughout their entire occurrence, is a stratum of limestone, standing nearly vertical and representing a variety of metamorphic stages, from a compact gray form to highly crystalline marbleized varieties and extensive masses of calcspar. The iron-deposits appear as bold "blocks," vein-like outcrops, and broad, dome-like bodies, as will be more particularly described below.

Four Hill group comprises eight or ten different outcrops. Of these, the northern and perhaps the most important, is a bold knob about 40 feet in height and 40 feet in diameter, rising from the northern slope of the ravine. It is comparatively a solid mass of remarkably pure magnetic oxide of iron, having a fine grain like the texture of steel. Along the western side it is curiously intermixed with calcspar, which mineral occurs freely in the neighborhood. From this one outcrop alone may be quarried several thousand tons. Southward, on the line indicated throughout a distance of half a mile, occur similar, though smaller, outcrops, having the form of large bunches, except on the southern end and near the Gold Valley divide, where the outcrops are more linear and vein-like. At this end also the ore is more highly oxidized, approaching hematite in composition. From the topography of the Four Hill region, which is in general a rough, rapidly rising flank of Spencer's ravine, there are good facilities for getting the ore down to the ravine bottom, where a road or tramway will afford connection with the proposed site of the works. By simply quarrying the surface-ore, it is estimated that twenty or thirty-five thousand tons may be made available; and this without making any allowance for the downward continuation of the bodies, or for those masses which exploration is sure to develop.

The Gold Valley deposits first appear nearly or quite a mile distant from the Four Hill deposits, but preserving about the same general direction. The main body in this series lies near the bottom of the valley, presenting a smooth, glacier-worn, and rounded surface, standing out prominently above the inclosing rock and soil. The superficial area of this outcrop is hardly less than 60,000 square feet, and the slope of the surface, and its projection above the contiguous soil, indicate a thickness of, say, 40 feet. This would give about 300,000 tons as the quantity of ore available in this bed alone, for quarrying. About 500 feet further south, a similar but smaller outcrop appears, and there is a probability that the two are connected beneath the surface.

Quantity.—We think it safe to say that the aggregate amount of ore in sight in the Gold Valley and Four Hill deposits is not less than 350,000 tons. This estimate is based on surface measurement of the outcrops, and on such assumed average thickness or depth, for each outcrop, as its projection or elevation above its inclosing rock would fairly indicate; not taking into account any probable continuation of the ore in depth, or any connected deposits extending beneath the soil, and concealed from view. It is quite probable that a much larger quantity than the amount named will be found; since it is not likely that the whole of the deposit is exposed to view. Baron Von Richthofen, the eminent geologist, who carefully examined this deposit several years ago, estimated 1,400,000 tons as the probable quantity available for quarrying; and although we do not place the amount "in sight" at more than 350,000 or 400,000 tons, we still think it quite probable that his estimate will be fully confirmed and exceeded by actual development.

Quality.—These deposits consist chiefly of magnetic iron-ore of excellent quality. This is one of the most important ores of iron. It is the principal ore of Norway, Sweden, and Russia. The Dannemora mines furnish, from extensive open quarries, 150 feet broad by 500 feet deep, the celebrated Swedish iron, largely imported into England for the manufacture of steel. In some bodies of the Four Hill group, the ore is almost pure magnetic oxide, presenting, when freshly broken, a clean, shiny, iron-black fracture, free from any impurity, and containing about 70 per cent. of metallic iron. Other portions of these deposits contain the magnetic ore, mixed with calcspar and dolomite, the intermingled minerals being desirable as a flux. This character of ore, although containing less percentage of metallic iron, say 50 per cent., is more valuable for smelting than the first.

The mass of the deposits in Gold Valley contains a more siliceous ore and carries from 40 to 60 per cent. of iron. The following is from an analysis made by Prof. H. Schrotter, of Vienna, to whom a specimen of the Gold Valley ore was sent for examination. He reports the quantitative determinations as follows:

Protoxide of iron	26.40	Equal to 60.68 per cent. iron.
Peroxide of iron	57.40	
Silicic acid	15.87	
Carbonate of lime and loss	0.33	
	100.00	

We have also caused examinations to be made by Prof. Thomas Price of specimens of ore from the various deposits. He reports that he finds nothing practically deleterious in the composition of the ore. Tests made for sulphur, phosphorus, and titanium show only the most minute traces, too slight to be practically considered; while the percentage of iron in the poorest selected specimens was 34 per cent., and in the better pieces 41, 55, and 70.

He regards the ores as of excellent quality and capable of being mixed to great advantage for smelting purposes. It is probable that the average yield of the ores when mixed for smelting will not be less than 40 per cent. of metallic iron.

At the present day the cost of laying down imported iron at San Francisco is about $60 per ton.

The average price of pig-iron in San Francisco, during the past six years, has varied considerably, as may be seen from the following statement:

Statement showing the average price of pig-iron per ton during several years at San Francisco.

Year.	Price per ton—coin.	Year.	Price per ton—coin.
1866	$46 82	1871	$50 to 55
1869	37 98	1872	50 to 55
1870	31 28	1873	45 to 55

Table showing the importation of iron and steel at San Francisco during five years. (Compiled from published statements.)

Form.	1868.	1869.	1870.	1871.	1872.
Pig .... tons.	16,659	13,820	8,563	5,399	14,341
Bars .... numbers.	314,683	326,719	204,398	99,147	279,351
Bundles .... numbers.	96,753	143,184	112,022	55,508	78,974
Plate .... pieces.	23,689	18,478	30,826	6,754	25,828
Sheet .... cases and bundles.	24,072	....	....	....	46,894
Sheet .... cases.	....	1,181	2,293	1,054	6,000
Various .... bundles.	75,000	....	....	....	....
Various .... pieces.	....	34,910	30,536	45,502	89,969
Nails .... kegs.	....	....	103,830	150,212	229,740

Table showing the importations of dutiable iron and steel, expressed in weight, at San Francisco, from foreign countries, during three years. (From the records of the custom-house.)

	1870.	1872.	1873.
	Tons.	*Tons.*	*Tons.*
Pig	7,213	6,792	14,341
Bar	5,213	2,292	6,338
Band, hoop, &c	963	682	1,491
Sheet	3,076	2,691	4,715
Old and scrap	1,387	2,119	5,838
Railroad bars, iron	3,978	16,067	15,812
Railroad bars, steel	....	....	1,637
Anchors, chains, &c	212	....	240
Miscellaneous, (estimated)	8,500	10,000	15,000
Total ... say.	30,000	40,000	65,412
Total invoice value	$1,053,266	$1,256,397	$2,361,629

This statement does not include domestic iron, of which large quantities are brought in various forms.

COPPER.

Although California possesses many copper-mines of great producing capacity, they have not been extensively worked during the past year, owing to the low price of the ores and the abundant supply from the neighboring State of Nevada. The mines of Copperopolis, Calaveras County, have been idle during the year. The Newton mine of Amador County is the only copper-mine in California which has been worked below the water-level. Here the process used is that known as leaching. The ores of the Napoleon are now being worked by the same process. At several points near the line of the California and Oregon Railroad, mines have been opened down to water-level. The ores are shipped to San Francisco, and sold by samples for export. The samplers keep no record of the relative product of California and Nevada, and it is therefore impossible to state the production of California.

The Mining and Scientific Press gives the following account of the method of sampling practiced in San Francisco:

> Copper ores are bought by the unit or per cent. of copper contained, which, of course, depends upon the grade of ore. Less than 16 per cent. ore is not very salable. The price per unit varies here more than it does in the East or Europe, for one reason, because we have to pay as much for the freight on low as on high grade ore. The scale o prices per unit at say $2.25 per unit for 20 per cent. ore, and $2.75 per unit for 30 per cent. ore, for instance, are for the following reason: Suppose such ore to be worth at home markets $4 per unit in gold.

20 per cent. at $4 per unit	$80 00	per ton at home.
Freight, insurance, commission, &c	35 00	
Balance, 20 per cent., at $2.25	45 00	per ton; price here.

> Now, if we take the 30 per cent. ore, we have the following:

30 per cent., at $4, equals	$120 00	per ton at home.
Freight, insurance, commission, &c	37 50	
Balance, 30 per cent., at $2.75	82 50	

> There is, therefore, a difference in charges on commission according to the percentage, and the insurance is, of course, higher on higher grade ore.

The ore, on being sent here, is systematically sampled by persons in the business. A certain proportion of the shipment is crushed, and then spread out and thoroughly mixed over and over. From this samples are taken at random, and placed in small bottles for the use of the assayer. By the method employed a good average of the whole lot is obtained. The seller takes his samples for assay, and the buyer his. The assays are all made by the humid method, and a certain proportion—one and three-tenths—is deducted, to agree with the fire assay. To show the means employed to get at the value of the shipment, we will give an illustrative invoice, or bill of sale, of ore:

1 car-load, 200 sacks		20,000 pounds gross.	
Tare, pounds	200		
Moisture, pounds, as per assay, say 2 per cent	400		
		600	
Net or dry weight		19,400	
19,400 pounds			$8\frac{584}{2352}$ tons.
			Per cent.
Sellers' assay			21.40
Buyers' assay			21.20
Average			21.30
Allowance for humid assay to fire assay			1.30
Net assay			20.00
20 per cent., at $2.25 per ton		$45 00 per ton.	
$8\frac{584}{2352}$ tons, at $45 per ton		371 17	

Copper-ore always sells by the ton of 2,352 pounds, or 21 hundred-weight, (4 quarters 28 pounds making a hundred-weight—112 pounds.)

Moisture is to be taken into consideration in this connection, and it makes considerable difference in the net weight of the ore. The Nevada ores, as a general thing, contain about 2 per cent. in moisture, but some run as high as 3, 4, and 5 per cent. One mine—the Ella, in Nevada—has run as high as 20 to 25 per cent. in moisture. The carbonate ores never contain less than 1 per cent. moisture, but pure sulphuret ores sometimes contain as low as a tenth of 1 per cent., but generally three or four tenths. Most of the moisture is mechanically combined.

The bluestone-makers buy some copper-ore, but the demand from that source is limited. They prefer high-grade carbonate ores. The bluestone men pay a high price for small lots, as the demand for bluestone is good. It now sells at 12½ cents per pound, whereas in the spring and summer it sold below 10 cents.

ALPINE COUNTY.

For information concerning this remote and not easily accessible part of California, I am indebted to Mr. Lewis Chalmers, and to an elaborate review of the mining industry of the county, published in the Alpine Miner.

Silver Mountain District.—This is the oldest district in the county. During the years of the great excitement in Washoe, extravagant expectations were entertained of this region also. That these hopes have not been realized is not proof that they were utterly unfounded.

The Mountain Company is one of the oldest and most prominent locations in the district, and for years was held in high estimation by the owners, and looked upon with favor by mining experts. A tunnel was driven through the ledge at an altitude of over 1,000 feet above the town, with promising results; but the cost of building a road to the mine on this high level, the comparatively limited amount of ore that could be extracted above the tunnel-level, and the expense of erecting hoisting-machinery to work below that level, led the company to suspend operations at that point, and to drive a long tunnel from the base of the mountain to open up the deposit at a depth commensurate with its magnitude. After persevering six or seven years in this work, the company stopped for want of means at a point just short of fruition. With the acquired experience of the present day in this species of mining, and the modern appliances in extracting ore and transporting it over heretofore inaccessible routes to the place of reduction, a more economical and profitable method of attack would have been chosen.

The George Washington, in the same mountain-range with the Mountain mine, is another location that once excited great hopes in the breasts of its owners, and caused them to expend a large amount in its development. This too, like the foregoing, never repaid the outlay upon it; because the refractory ores could not be worked at a profit. A test of the ore of common grade as it comes from the mine was made by Mr. B. E. Hunter, at the Schenectady Company's mill last summer, and gave a return, by the wet method of treatment, of a fraction over $23 per ton. It is understood that a Chicago company has either bought the mine or is negotiating for it.

The Pennsylvania mine, about two miles from the town of Silver Mountain, on the opposite side, is another old location upon which a large amount has been expended, under the stimulus of a bold outcrop, showing good evidences of richness when once fairly opened up. A tunnel of about 1,000 feet was driven through the solid granite, piercing the ledge at a vertical depth of about 800 feet. At this point the ledge was found well defined and carrying ruby silver in limited quantities. When it cost $25 per ton for reducing ore at the local mills, ore of moderate grade could not be profitably worked. A recent test of the average ore of this mine at the Schenectady mill gave a yield of over $50 per ton. The owners being few in number and poor men, are compelled to wait for capital to make their mine available.

Scandinavian Cañon contains the only mines of the district now in active operation, the Exchequer and the IXL, which have been pushed forward during the year, in the face of troublesome delays, accidents, and discouragements, by the superintendent, Mr. Chalmers, who acts for both companies. The following summary is condensed from his annual report to the Exchequer Company:

New hoisting-works have been completed, and have proved themselves equal to any demand that may be made upon them. The engine-shaft has been sunk 100 feet; 9 feet 4 inches by 4 feet 6 inches in the clear, and substantially timbered with framed timber 8 by 8, and sawn logging 2¼ inches, divided into two hoisting compartments with 4 by 8 bretticing, and all lined with inch boards. The pumping is done by one of Blake's steam pumps. At the bottom of the shaft the excavation was increased in the direction of the longitudinal axis of the shaft, 5 feet by 7 feet, to form a station for loading and unloading. Twenty-six feet from the hoisting-floor an adit was run north 10° 30′ east, 84 feet, to clear the shaft of surface-water, which it did effectually, reducing the output from 480, and sometimes 600 gallons an hour, to 120. While sinking, the pump could not be used. From the bottom of the engine-shaft a cross-cut was run north 78° west, 6 feet by 7½ inches in the clear, striking the hanging-wall of the lode 25 feet from the center of the western hoisting compartment, from which it was carried 9 feet farther, through the foot-wall, into the porphyritic country rock. Drifts were then run on the lode both north and south; north 212 feet, south 46 feet.

At a distance of 70 feet from the main door of the hoisting-works, advantage was taken of a large fissure between two masses of rock standing almost vertically, with smooth walls, and a new ore-dump constructed therein, with a self-loading chute, and connected with the engine-shaft by a strong tramway built on trestle-work.

The roads to and about the mines have been thoroughly overhauled. An unusually early, and, for the season, unprecedentedly deep fall of snow came on before the winter supplies were got to the mine; but all hands being put on for its removal, the work was finally accomplished.

The lode was struck on the 6th of August, running north 0° 30′ east, south 25° 30′ west from cross-cut, and dipping 63° east. It measured 4 feet from wall to wall, and near the center was a rich seam of quartz, from 8 to 12 inches wide, widest in the bottom of the drift, assaying from $100 to $2,000 per ton. Drifts were immediately run both northerly and southerly; the north drift, north 0° 30′ east; the south, south 25° 30′ west, on the lode. At 48 feet from the cross-cut the lode began to veer round to the west, until its course is now north 9° west, and at 31 feet south of the cross-cut its course was south 61° west.

After running 45 feet south, stoping was commenced opposite the cross-cut, and a piece of ground 39 feet long by 14 feet high was stulled and stoped. This stope and the drifts have given 120 tons of good ore. In carrying the excavation south, this ore-body gave out 36 feet from the cross-cut, both longitudinally and vertically. The work south was therefore discontinued.

Pushing explorations north, good stones of ore have been found all the way, but no large body—nothing sufficiently extensive of itself to supply the mill with 16 tons a day (its full capacity,)—until within a few feet of the present face, where the lode has widened out to the whole width of the tunnel, and improves daily in approaching the rich ore left at the bottom of the winze. Taken from this chute near the cross-cut, there are now in the assay office two blocks of ore, averaging 10 inches in width, weighing 12 pounds, literally full of ruby silver, worth $500 per ton.

Soon after striking the lode, extraction was confined to the stope mentioned, and the piece of ground also before mentioned near the winze. These stopes and workings gave about 160 tons of ore in all. Finding that he could not yet run the mill regularly, and that spasmodic running would not pay, Mr. Chalmers shut down the mill after making two runs, and devoted all his energies and the whole force at command to the development of as much ore-ground as possible, for extraction in the spring, so that when the communication opens, he may have something to depend on for a continuous ore-supply.

The north drift will furnish ore all the way in places from the cross-cut to the 200. From the 200 it is thought there will be good stoping-ground to the winze, and onward for a distance of 240 feet in length, by 200 feet deep.

A contract has been let to sink the engine-shaft to the 200 at $25 per foot. The shaft will cut the lode, if it keeps its present pitch, at the 148, and will require a cross-cut east from the 200 of 27 feet to reach it. Operations will then be continued by driving and stoping upwards.

In Mr. Chalmers's opinion, the Accacia ground should be opened up by tunnel, and the connection made with the engine-shaft. Surface assays from the croppings of this lode gave $77.40 in silver, with distinct traces of gold. An offer is made to drive the tunnel till it strikes the lode, some 150 feet, at $14 per foot. After reaching the lode it can be run for $10 per foot.

The remodeling and extension of the company's mill has been completed, at a cost of $13,495. A new boiler was substituted, since which the mill does its work with ease, reducing 16 tons a day at a cost of $6.25 per ton. A crusher to break the ore would give 20 tons a day and reduce the cost to $5 per ton. In the old mill it cost $45. A short run on the ore, produced, during earlier developments and works of exploration, but which, lying so long on the dumps, had got considerably mixed up with worthless stuff, gave bullion worth $464.18, (gold, $87.54, and silver, $376.64) according to assay. The mint net return was $421.90. Another short run on IXL ore not only repaid the running expenses, but left a profit of $185.25. There are now in the mill about 120 tons of ore. Mr. Chalmers anticipates no difficulty in taking from any milling-ore at least 70 per cent.; the tailing-tanks and slime-reservoirs conserving the remainder for reworking at a future time. So soon as he can turn out 30 tons a day, he will recommend the construction of a wire tramway which will cost, complete, per mile, $10,000, according to Mr. Hallidie, the patentee, who has just finished one for the Chicago mine, which carries the ore from mine to mill, a distance of 1¼ miles, for 50 cents per ton—30 tons per day—taking timber and other mining supplies back on the ascending line gratis.

The company's saw-mill, with its new turbine, ran for two months, and during that time furnished all the timber required for both mine and mill erections, winter-supply of mine timber, and logging, besides $1,800 worth sold.

Work on the IXL has been prosecuted with vigor, so far as means would permit. Mr. Chalmers reports to the directors of the company in London, under date of January 1, 1874, that during 1873 he has cleaned out and retimbered the adit-level from the 32-inch engine-shaft, and replaced the old trackway and water-boxes with new ones; unwatered 66 feet of shaft and 81 feet of cross-cut and drifts; cleaned out and retimbered 81 feet of tunnel and drifts at the 98; drifted on the lode at the 98 for 19½ feet; excavated 504 cubic feet of hard rock for water-tank at the 98; sunk, timbered, and bretticed the engine-shaft 109 feet in two compartments, and placed two steam-pumps and steam and water pipes therein; excavated 1,344 cubic feet of hard rock for a station at the 200, (14 by 12 feet in size, and 8 feet high;) excavated 500 cubic feet of hard rock for water-tank under this station; driven a cross-cut 105 feet in very hard rock, 8 by 6 from engine-shaft, to intersect the IXL and Ophir lodes, at the 200; driven on the Express cross-lode 26 feet; north on the IXL lode, 50 feet; south on the IXL lode, 24 feet; and in the new adit on the Ophir lode, 80 feet; cleaned out 700 feet of the lower tunnel, and relaid the car-track for that distance; stoped down therefrom 1,080 feet of quartz, mostly pay-ore; cleaned out upper tunnel and relaid car-track; stoped out from under floor 200 cubic feet of quartz, mostly pay-ore; cleaned out an intermediate drift between the upper and lower tunnels 47 feet and found pay-ore; pumped out 130 feet of shaft and 150 feet of drivings after boiler-tubes burst; and replaced the pump at the 200 by a new and more powerful Blake.

On the surface, the year's work includes the grading of a ditch around the hoisting-works to carry off water; laying 600 feet of car tramway for bringing firewood from timber ranch for hoisting-engine; building 720 feet of chute from end of tramway to hoisting-works; excavating 2,860 cubic feet of hard rock for boiler-house, erecting the boiler-house and putting in boiler; cutting 700 feet of ditch to bring clear water for boiler feed; cutting and delivering at hoisting-works 600 cords of wood, 3,829 feet of stull timber, and 4,300 loggings. The IXL assisted the Exchequer Company to keep the toll-road to the mine in repair, and to clear the same of snow, so as to get up winter supplies. The expense of mining supplies, wood, timber, and freight was $6,221.04.

The only misfortune encountered was the break-down of the boiler when being worked at a very high pressure, in order to drive the pumps hard enough to get rid of an enormous influx of water from a crevice in the north drift on the 200-foot level. This involved an expense of $1,846.38 for a new boiler and boiler-house. No apprehension need now be entertained of the recurrence of a similar catastrophe, as there is now steam enough to keep the water under perfect control. Were the Ophir adit completed from the 100th it would relieve the pumps considerably, and soon pay its cost in saving fuel for steam.

Believing that much of the waste rock thrown away by former owners as too poor to work when an expensive reverberatory roasting was a *sine qua non*, would pay if crushed wet and amalgamated with bluestone and salt without roasting, Mr. Chalmers sent 49 tons taken from the waste dumps to a neighboring mill to be treated in this way; and although the customary charge for milling, of $15 per ton, ran away with all the profit, and a good deal more, he established the fact to his own satisfaction that there is no difficulty in obtaining from the ore a fair percentage without roasting, and that even $20 ore would pay a profit in the company's own mill.

The 49 tons took just three days to work, part of which time was consumed in hand-breaking the ore, which was mostly in large chunks and excessively hard. The mill expenses did not amount to $100 per day—say $6 per ton. The bullion produced sold for $464.57 at San Francisco mint; so that there was an actual profit on this small batch—for which the mill had to be cleaned up, taking nearly half a day of the above three days—of over $164, besides the tailings—the perquisite of the mill.

The Express lode, on which little value has ever been set—its appearance on the top not justifying it—has turned out to be a cross-lode, running north 32° east, south 32° west, very much broken up and poor in the 26 feet run on it. What effect it may ultimately have on the intersected lodes cannot yet be positively said, the opening having been driven only 25 feet on the main lode, since getting through the cross-lode, and not yet having reached its junction with the Ophir south. Up to January, 1874, the effect had been far from beneficial on the main lode—disturbance without enrichment, a widening of the fissure without the deposit of ore. The farther from the cross-lode the better does the main lode show. Quartz with ruby now makes its appearance, and though only from 2 to 6 inches wide, bids fair to enlarge as it is driven upon—assays from selected stones giving $33.54 per ton—while every day brings nearer the rich bonanza, which at a depth of only 50 feet from the grass roots gave its original proprietors $50,000 from a few feet of lode.

The south drift is in broken-up vein-matter—caused, no doubt, by the close proximity of the Ophir, which will be cut within 20 feet of the present face, or about 44 feet from the cross-cut. Both the IXL and Ophir lodes fill the whole of their respective drifts, which are 5 feet wide.

The company has an excellent mill-site, ample water-power for a steam-mill of any capacity, timber in abundance; in fact, everything required for an efficient and economical working of both mines and mill. Snow—a great drawback at present—would be rendered less troublesome by the wire tram-way, which for an expenditure of $22,000 (or $11,000 per mile, as per Mr. Hallidie's estimate) would bring 50 tons a day to the batteries, at a cost of 24 cents per ton.

Alpine district.—This district is bounded by Silver Mountain on the south, Raymond on the west, Webster on the north, and Monitor district on the east. Its water-power, supplied by a frontage on the East

Carson River of some seven miles, is unsurpassed; and the best of timber in sufficient quantities for years to come, in connection with numerous ledges of silver-bearing ore, makes this a locality of more than ordinary interest. The rich ledges of the Scandinavian Cañon have a bearing direct for the heart of this district, and many of them have been sufficiently prospected to give them a market-value in the eyes of mining experts.

The Saint Helena mine, supposed to be the northern extension of the Buckeye No. 2, now owned and worked by the Exchequer Company of London, has had considerable work done upon it, developing a good quality of ore in moderate supply. The deepest working does not extend below 80 or 100 feet, at which point the ledge is large and well defined. This mine is owned by John Weis & Co., of Markleeville, and is valued at a round figure, notwithstanding the present depression in mining matters. There are several other promising ledges in the vicinity of the Saint Helena, all of which will find their natural outlet at Markleeville.

Mount Bullion is a mountain of large extent, seamed with massive ledges, the outcrops of which, in places, reach an altitude of 40 feet above the surrounding country. The Mount Bullion Tunnel Company, an English institution, started at a point on the west bank of the Carson River, at Bulliona, and drove into the mountain a distance of 2,000 feet, to cut a belt of ledges which cross the eastern face of the mountain. They stopped about 250 feet short of the point where the main ledge might reasonably have been expected to cut the plane of the tunnel.

The Santa Eulalia Company once had a vast property in this district, consisting of a large number of ledges and about 2,000 acres of the finest timber-land in the State. After expending several thousand dollars in 1863 and 1864, when the first reaction came after the great excitement of 1860-'63, they allowed everything to go by the board.

The Good Hope mine was located in 1863, and worked spasmodically up to the early part of 1867, when the company became bankrupt, and it fell into the hands of the creditors. A first effort was made to develop the mine by an incline shaft following the foot-wall, but at a depth of 32 feet the water became too strong for hand control, and work was suspended. The next effort was by a tunnel running into the hill to strike the ledge at an obtuse angle, and thence by following the ledge south into the mountain. The tunnel from its mouth in for a distance of 200 feet penetrated a country-rock of soft porphyry, when it cut a clay wall 6 feet thick, which drained off the water from the incline-shaft above referred to, showing this clay to be the true east wall of the ledge. After passing this wall for about 20 feet, the vein-matter consisted of a mixed porphyry and quartz, showing some veins of quartz of a thickness of 8 inches, which were quite rich in gold and silver. On the west wall a solid vein of quartz 3 feet thick was struck, which was thence followed in an unbroken chain southward into the mountain 400 feet. At points in this distance the ledge showed a width of 10 feet, while the average would be about 5. The ore in places is much decomposed, while in others it requires a free use of powder to extract. The dip of the ledge is about 40° to the west, with a strike averaging nearly due north and south. The ore at the depth attained by this tunnel is of a low grade, averaging by mill tests $12.75 per ton. At the time of the suspension this grade of ore could not be worked to a profit, but with the facilities this mine offers for cheap extraction, and the improved methods of reduction, it can now be made to yield a profit of at least $2.60 per ton.

Monitor district.—From a long distance away the curiosity of the traveler is aroused by the many-tinted peaks of this region. There is the General

Shields, of a bright buff color; Red Mountain, of a deep vermilion, and Monitor Peak, with all the intermediate shades between buff and vermilion. The vast outcrops of the ledges cut across the faces of these lofty mountains, some peering out from among, while others overtop, the tall pines that are scattered over their sides. This, like Alpine district, has the full advantage of an unlimited water-power with its five miles of frontage on the Carson River. From Bulliona to the town of Monitor, a distance of two miles, following the windings of Monitor Creek, the traveler crosses one of the most extensive belts of mineral-bearing ledges in the whole country. The Florence, Manchester, Three Sisters, Mountain, Constitution, Abe Lincoln, Hercules, Blind, Detroit, Chicago, Esmeralda, Ohio, Tarshish, Sunshine, Wild Yankee, and America, are but a few of the many that were located and worked upon in the early days of the district. In the fall of 1862, John D. Marks, Jacob Brandebury, and Warren Burright, working the Esmeralda lode, about half a mile below the town, put a blast into a point of rock jutting out into the creek, just below where they were working, which blew off perhaps half a ton of ore that assayed all the way from $65 to $3,000 to the ton. In a short time the good news spread and began to attract the attention of parties from the outside, who visited the locality during the winter, and by spring a great rush ensued. It is safe to say that that one blast in the Esmeralda cropping laid the foundation of the mining operations that have been carried on so extensively, for up to that time nothing more than fair indications had been met with. The history of the Marion, the name of the incorporation that undertook the development of the Esmeralda lode, subsequent to 1863, is but a repetition of those heretofore given in Silver Mountain and Alpine districts—inadequate capital, discouragement, and final suspension. It is a firm and settled conviction in the minds of all the old settlers that in the Marion there is the making of one of the richest mines on the coast. The discovery of the Florence lode was the next great sensation. A man by the name of George Probasco came into camp early in the spring, and spent a few days in looking around. On one of his excursions down the creek, in following along its bed, he found under the top of a fallen tree a mass of blue clayey matter that excited his curiosity. Upon closer inspection, with pick and shovel, it proved to be the top of a ledge which had become much decomposed by the action of the water of the creek. In this mass of clay he found specimens of ore that had every appearance of native silver, but which in reality were nothing but a rich galena. Probasco went nearly crazy over his discovery, and when, at a later day, Dr. Hughes, of Carson, offered him $12,000 coin for a controlling interest in his mine, he quite indignantly refused the offer. The result is that his mine remains to-day in much the same condition it was when discovered.

The Manchester mine is owned and worked by a San Francisco company; they made some important developments, clearly proving the value of their property, but on the death of Mr. Henry Dreschfeld, the leading spirit of the organization, work was suspended in the early part of 1865, and, though frequently spoken of since by members of the company, has never been resumed. On the adjoining claim on the Manchester lode, known as the Merrimac Company, a tunnel was driven a distance of nearly two hundred feet, showing ore of a good quality of the same general character as that in the first-mentioned mine. This ore is argentiferous gray copper. The depth on either mine was comparatively slight, but sufficient to demonstrate the continuity of the vein, both vertically and horizontally.

To cut this ledge, the Florence, and some half a dozen others in the same belt, a location for a deep, long tunnel was made by J. P. Ray, S. G. Lewis, and others, and called the Winchester. For some years Mr. Ray vigorously pushed work on this tunnel, and drove into the mountain 1,065 feet, cutting in that distance the Florence lode some 300 feet in, and at a depth of about 150 feet. The lode was well defined, 15 feet thick, with a vein of ore of 5 feet. At 648 feet the Manchester lode was cut, showing a large ledge with clay casings on both sides. This ledge gave good assays, but nothing was done toward opening it up further than the running through it. At the extreme point reached by the tunnel, another ledge was struck into, but never cut through. This last ledge is supposed to be the Constitution, which crosses the road and creek about one mile below town.

The Constitution, just below the Globe mill, owned by the Active Company, of New York, is a vein, 20 feet between the walls, and carrying an argentiferous copper-ore with flakes of native copper liberally interspersed through the gangue. But little work has been done upon this mine. It was at one time bonded to the Globe Company for the sum of $3,000.

The Chicago and Detroit, located on the Esmeralda belt of ledges, has cut three veins in a distance of 300 feet, on one of which a drift has been run 100 feet, showing a continuous vein of low-grade ore that can now be made to pay by the improved methods of reduction. One of the veins which gives the greatest promise has not been touched further than running through it with the main tunnel.

The Imperial Company is an English organization, which commenced at a point on Carson River, just above Bulliona, to drive a double-track tunnel from the river under the summit of Mount America, and thus cut all that vast belt of ledges lying between Monitor and the river. The company persevered until 1,300 feet of tunnel had been made, when its means were exhausted. It is hoped that work will be resumed at no distant day.

The property of the Monitor and Northwestern Companies consists in a tunnel location, starting at a point on the river, and running thence nearly east to a point under the center of Monitor Mountain. This tunnel is designed to open up the entire belt of ledges on the north side of Monitor Creek, between the river and the town of Monitor. It penetrates under Red Mountain to a depth of 1,300 feet, and under Monitor Mountain 1,600 feet. In its course it is expected to open up as many as fifteen or twenty lodes, and among that number the Mountain lode, from which assays have been had ranging all the way from $20 to $3,000. In such high estimation is this Mountain lode held that Mr. John P. Ray, of Monitor, has bought the entire original location, and is spending a large sum in its development, with encouraging results. The tunnel to open up this mineral belt has been driven into the mountain a distance of 800 feet. The entire length is designed to be 6,000 feet. The reason that work has not been pushed on this branch of their operations is, that the companies own very extensive locations on the great Tarshish and Esmeralda belts of ledges, and work has been very extensively conducted at that point, as offering a more immediate return to the owners. The Alpine tunnel starts in the side of the mountain about half a mile below town, and was driven 500 or 600 feet to the north toward the Tarshish mine, and under a massive outcrop which was believed to be the real continuation of that mine. Ore was found in limited quantities diffused through the entire length of this main tunnel, and it was thought that this body would put the mine on a paying basis. These calculations were based upon assays, the average of which, as returned by the United States mint at Carson, was a fraction over $18 the ton. Unfortunately for the company, when the ore was mined in bulk and crushed at the company's mill, the average did not reach above $9 or $10.

During the time all this tunneling had been going on in the Alpine a similar work on the Silver Glance mine, immediately under the Alpine, and at the creek level, had been progressing, for the purpose of opening the Esmeralda belt at a lower level than hitherto attained. A main tunnel was driven north under the mountain 400 feet, and, turning nearly at a right angle, thence west something over that distance. This west drift is being pushed toward the west wall, with the expectation of finding a vein of ore on that side of the ledge. The vein-matter carries a small quantity of ore the whole distance, with a perceptible increase for the last 40 or 50 feet, which gives the company hopes of getting a paying body in that direction within a short distance. A winze was sunk from the Alpine tunnel, connecting with the Silver Glance, thus prospecting the intermediate ground, and affording ample ventilation for both mines. At a distance of some 200 feet west of the main tunnel a vein of larger proportions than ordinary was encountered, and a drift was started on it following to the south, where the ore was found to improve in quality and quantity, swelling in places to three feet. The most favorable point on this vein was selected, and a shaft started downward, following the course of the vein. At 75 feet a level was run off to the south on the vein, which at this point had an average width of 3 feet, carrying ore that gave an average by assay of something over $50 per ton. About 400 tons has been raised from this shaft, and is stored in a capacious and substantial ore-house at the mouth of the mine. It is not expected that this entire 400 tons will average as high as the figures above given, for the reason that everything carrying ore even in limited amounts was saved. Sinking the shaft was again resumed below the 75-foot level, and was pushed down until a total depth of 100 feet was attained, when the water became too strong for hand control, and work was suspended during the erection of steam-hoisting works. In the mean time this shaft has been enlarged to two compartments, and substantially timbered, and is now again being pushed down as fast as two sets of men can carry it, with favorable prospects.

The company has a mill on the river, driven by water-power supplied by a flume some 1,600 feet in length. This flume gives a fall at the mill of 26 feet. The volume of water is not far from 3,000 inches, miners' measure, which turns a large turbine wheel that gives the motive power to the mill. The mill is of ten-stamps capacity, capable of being enlarged to twice that number, and is fitted up with pans, settlers, &c., for the economical treatment of ores.

The Schenectady Silver-Mining Company, better known as the Tarshish, was considered one of the great mines of the coast, but unfortunately it has not maintained that reputation by producing bullion. This is an Eastern organization, the majority of the shareholders being residents of Schenectady, N. Y., where the office of the company is located. The work of developing this property commenced in the fall of 1866, by contract to John P. Ray for the making of six hundred feet of tunnel. The work was vigorously pushed, and the contract completed early in the spring of 1867. The last blasts in finishing up the contract broke through the porphyry which constitutes the east wall of the ledge, into a soft, white, putty-like substance, apparently worthless, but really containing a large percentage of black sulphurets which, upon assay, proved immensely rich. This soft ore, in its natural state, assayed as high as $500 per ton. A load of this ore was immediately taken to Dall's mill, in Washoe Valley, where it was worked by the Freiberg process, yielding $400 per ton. This so encouraged the company that they immediately sold their reserved stock, amounting to 20,000 shares, thereby raising a fund of $40,000 with which to prosecute the work of opening the mine. This was pushed vigorously until the early part of the following winter, when funds were exhausted, and the mine was closed. There were two workings of the ore during this period, which demonstrated that it could be worked profitably, provided there was enough of it. After about a year a new superintendent was sent out, and remained in charge for three years, during which time he extracted and sold about $10,000 worth of ore, beside having a large amount of prospecting done, which demonstrated, in his opinion, the necessity of a mill to fully prove the value of the mine. The result was a magnificent mill of twenty stamps, costing somewhere in the neighborhood of $100,000. The mill was completed early in 1872, and was started under still another superintendent, when the first thing proven was that the White roasting furnace, which had been adopted by the superintendent over the Stetefeldt on account of economy, was a total failure; therefore the ores would not amalgamate for lack of chlorination. The mill was then altered and adapted to wet crushing and raw amalgamation. One hundred tons of the best average ore of the mine was run through the mill and down the creek with no results in bullion, after which the work was again suspended, and the manager was recalled. It is reported that during the past summer and fall, Mr. B. E. Hunter, at present in charge of the mine, has been quietly experimenting in working the refuse or waste rock of the old dump with a most gratifying result. In his first run, of something like a week, where he expected a return of $400, he got $900; and in a subsequent run of like duration he got somewhere about $1,300, showing that practice in treating the ore increased the results. Another run of a month gave a return quite as satisfactory as either of the foregoing. The reduction was by wet crushing and raw amalgamation. The Alpine Miner says:

> We believe the proper way to work the ore would be to crush wet, run the pulp over long sluices, and thus concentrate the ore, say ten tons into one, bringing the average up to from $100 to $150, and then roast in a reverberatory or Stetefeldt furnace, by which process from 90 to 95 per cent. of its value could be saved. By such a method of treatment the mill could be far more economically run, and a lower grade of ore than otherwise could be treated. One great saving would be in quicksilver, which, by the most careful management in amalgamating, wastes not less than one pound on the ton of ore treated. By concentrating one hundred tons into ten we would save 90 pounds of quicksilver, which, at present prices, ($1.30 per pound,) would amount to $117, certainly a very large item for two and a half days' run. The company's mill is capable of crushing 40 tons in 24 hours, and could be run at an expense, outside of the amalgamating department, not exceeding $1.50 the ton on the amount of ore crushed. At this rate a very low-grade ore could be worked at a profit. We confidently look for something of this kind being done at no distant day. It is certainly to the interest of the company to do something with their extensive and expensive property, to get even a small annual percentage on their outlay, for it is a well-known fact that no species of property deteriorates more rapidly by idleness than does mining and milling. In the mine, timbers rapidly decay and caves occur that become more expensive to repair the longer they stand, and the mill rusts and rots out by idleness quicker than it would wear out by every-day use.

The Globe Company owns a location on the Abe Lincoln and Hercules lodes, commencing at Monitor Creek on the north, and running south under the center of Globe Mountain, where a massive chimney or outcrop covers the entire crest; also the property of the former Worden

Company on the Esmeralda lode. A double-track tunnel, 6½ feet by 6½, is run into the mountain in a southeasterly course a distance of about 1,000 feet, with a side drift called the "east tunnel," 300 feet long, and a south drift 180 or 200 feet in length, and a second "south tunnel" of 200 feet. In at a distance of about 300 feet a large vein was cut into, which was denominated the "Abe Lincoln," but which was in reality the Hercules, with the former united into one massive ledge. At this point the depth from the surface was too insignificant to warrant any great amount of ore. At a point where the combing of a body of argentiferous copper made its appearance a winze was sunk a few feet by hand, when there was such decided improvement manifest that hoisting apparatus was obtained and an effort made to go down by aid of steam-hoisting and pumping-machinery. The Alpine Miner gives the following description of the difficulties encountered:

> People unacquainted with efforts to sink shafts in tunnels a long distance from the surface have little idea of the trouble and expense entailed by the operation. A steam-boiler and furnace has to be put up in a suitable building at or near the mouth of the tunnel, and the steam conducted thence in pipes thoroughly wrapped in wool-felting made for the purpose, which is about half an inch in thickness, and then an outer covering of cotton cloth close wrapped so that the edges completely overlap each other, and then the whole covered with a thick coat of gas or other tar which makes the covering entirely impervious to the air, thus cutting off the radiation of heat. In this manner steam can be conducted the distance of a thousand feet with no greater loss by condensation than 10 or 12 per cent. At the point decided upon where the shaft is to be, a large excavation, called a chamber, has to be cut in the solid rock and most substantially timbered with beams at least a foot in diameter. After this chamber has been made, which in height has to be not less than 18 or 20 feet, the engine and pump are placed in position, and the work of sinking can commence. The engine put up at the Globe was an oscillating cylinder of ten to fifteen horse-power, with a four-inch Cornish pump. The water was so strong that the pump had to be run all the time, and by the time that 50 feet had been reached the power was found insufficient for both pumping and hoisting, and the effort had to be abandoned. There was sufficient increase in the appearance of the vein and the quality of ore in that depth to justify a large outlay in reaching a greater depth below the surface influence of the creek. There was not sufficient money in the company's treasury to do this, and it was decided to drive the main tunnel to the Worden ledge, and thence following into the mountain to a point under the main outcrop.

In this direction 200 feet was made with a marked improvement in that distance. Work was suspended, presumably for want of funds; but it is said to be the intention of the company to start again in the early spring, and drive to the above-mentioned point, where, from surface indications, they believe that ore in sufficient quantities will be found to make the mine self-sustaining. At this point another tunnel will be driven in a southeasterly course to the center of Mount America, from whence, apparently, radiate a vast number of ledges, all having one common center, and that a mountain of mineral-bearing quartz. Without attempting to criticise operations which I have never personally examined, I may be permitted to say that these extensive tunneling operations in advance of actual developments of the mines are not usually favored by experienced engineers, and that the history of this company appears to afford a notable example of the difficulties, delays, expenses, and disappointments to which such a system of exploration is liable. The Alpine Miner, from which I have quoted above, argues with much force, after an elaborate analysis of the history of the mining enterprises of the county, that its resources have never been fairly treated, and that the grounds of the numerous failures of the past are independent of the real value of the mines themselves. There is, no doubt, much truth in this view; yet it must be remembered that the mistakes of owners and superintendents, which have ruined so many mining enterprises in Alpine County, and the lack of adequate capital, which has crippled so many, are connected with the unfavorable climate and location of the county. The difficulty of communication at all times, and particularly the severity of winter-storms, has raised the cost of labor and machinery and repairs, making dead work and construction work almost certainly ruinous in cost. In short, mistakes are more than usually likely and more than usually damaging, in a district so situated. The success of the Exchequer and the IXL would, by bringing back population, business, and hope, lead to improved communications and economical conditions in all respects far more favorable to mining industry.

INYO COUNTY.

This county, like Alpine, is situated on the eastern slope of the Sierra Nevada. It was visited in 1872 by Mr. A. Eilers, whose description of its principal mines will be found in the report for 1873. The following is a reply to one of the circulars of inquiry addressed to the county:

> The only mines in the county that were worked to any considerable extent during the year 1873 are the Union, at Cerro Gordo, and the Owens Lake Silver-Lead Company's claims at Swansea. The Union mine has been pretty extensively worked for several years, yielding more lead bullion during that time, probably, than any other mine in the United States. Belshaw & Beandry, the owners of the mine, were comparatively poor men when they began operations, some six years ago, but are now possessed of a competency, made in operating this mine. Suit was some time ago brought by the San Felipe Company, who claim to have the first or discovery title, for the recovery of the mine, and in a trial a verdict was rendered in their favor. Belshaw & Beandry are, however, running their furnaces and taking out about twenty-five tons of bullion per day. The Swansea claim is also a very extensive mine, and produces nearly as much bullion as the Union. This company own a majority of the San Felipe stock, and if they should eventually succeed in obtaining possession of the Union also, they will have as much as one company can manage. It is impossible to give anything like correct figures of the amount of bullion produced by these mines, as the owners are not at all communicative in regard thereto. Something of an idea may be gained of the amount, however, from the fact that hardly a team, within the last six years, of the large number engaged in hauling supplies for nearly all the people of the valley, has ever returned to Los Angeles (the point from which goods are sent into the interior) without taking out as much bullion as their twelve and fourteen mule teams could haul. How many teams have been thus engaged I cannot say, but quite a large number, as Inyo County has a population of some three or four thousand, and must require a large number of teams to supply her freight. The bullion, although hauled out of the valley at this rate, has steadily increased, until it is found necessary to engage more teams. A contract has been entered into with Nadeau, of Los Angeles, to haul this bullion. He has purchased eighty twelve-mule teams, and allowing that he will make the round trip from Los Angeles to Cerro Gordo every eight or nine weeks, it is thought it will take him ten or eleven months to haul out what is now on hand, to say nothing of what can be turned out by the furnaces in the mean time. It is estimated that one hundred such teams will be required constantly in hauling away the bullion produced by these two mines alone. This bullion is valued at from $150 to $700 per ton. Estimating, then, that each twelve-mule team will haul 20,000 pounds, eighty teams would take 1,600,000 pounds each trip; say that they make five trips to the mines in ten months, we find they will have hauled out 8,000,000 pounds, or 4,000 tons. It is said by those who claim to know, that this bullion averages $500 per ton; here, then, we have a total of $2,000,000 worth of bullion now corded up awaiting transportation out of the valley. This may seem an exaggerated statement, but when one goes there and sees this bullion piled up on either side of the lake—for a steamer is employed in taking it across the lake to the road—cabins built of it for temporary uses of the miners, visits the mine itself and sees for himself the enormous ledge developed and the hot streams of metal running from the furnaces, it will then be thought the figures here given ought to be multiplied by two. A great drawback to Cerro Gordo has been the scarcity of water, all required for the working of the mines and domestic purposes having heretofore been brought from a spring several miles distant and retailed at 15 cents per gallon. This difficulty will soon be obviated in a great degree, as some months ago a contract was entered into by a company to lay a pipe to bring the water in. Nine miles of 4-inch pipe is now on the ground, and the water-works will soon be in operation.

From the letter of a private correspondent I learn that the works at Swansea made about 750 tons of bullion during the portion of the year they were in operation. The lead bullion contained, for the most part, from $130 to $175 per ton.

The Santa Maria lead-mine is developing very encouragingly at a depth of 300 to 450 feet. The Union mine, or, as it may now be called, the San Felipe, the priority of the latter location having been established by the courts, is in as good condition as ever. Pipes have been laid by the Cerro Gordo Water Company, between Cerro Gordo and a spring eleven miles distant, and pumping-machines have been located at the spring, promising a supply of water in the course of a few months. A flume has been constructed by S. Stevens, down Cottonwood Creek, on the west side of Owens Lake, through which wood for charcoal and other use will be brought, securing great reduction of prices of fuel. All parties have been making bullion faster than it could be moved economically by teams; hence a general stoppage of mining and smelting work in the district at present, (January, 1874.) Business is dull.

Panamint district.—This district is situated nearly due east from Lagunita post-office and stage-station on the Owens River road from Havilah—distant from Lagunita sixty miles, and from Los Angeles two hundred and fifteen miles; from Independence, the county-seat, say one hundred miles. It was formerly known as the Telescope district, in 1861 and 1862, and is a lofty, bold range of mountains, lying between Panamint and Death Valleys; the main peak, called "Chiombe" in the native vernacular, rises to the probable altitude of 12,000 feet. The point of export and import for the mines will be Los Angeles, until the Southern Pacific Railroad has climbed Tehatchepa range and crossed the present Owens River road. There will be a good wagon-road diverging from the main Owens River road at Desert Springs, and thence by the old Slate Range road it will pass west of the large borax-deposits, and crossing the low divide at the head of the valley by a recently discovered pass, it will reach within three miles of the mines, when more formidable difficulties will be met with in Surprise Cañon. These will soon be surmounted, however, by a toll-road, and the Panamint mines will have a good wagon-road by the opening of spring, and the borax companies at Slate Range and Desert Springs marshes a good means of export for their borax.

But little work has been accomplished except a vigorous prospect of the district, the result of which has been the discovery and location of over 160 claims, and building by the miners of suitable winter-quarters and roads to the mines. Vigorous work has been commenced, by the owners, on the "Stewart's Wonder" claim, and on the Wyoming Company, by tunnel-mining on the lodes.

Both the lodes mentioned above are considered first class, the ores assaying from $200 to $1,500 per ton, and averaging from 5 to 15 feet wide. A 15-foot shaft has been sunk on the Esperanza, and developed a very rich stratum of ore about 18 inches wide, which probably will pay $600 or $700 per ton.

Nature has, in the Panamint district, saved the great expense and labor of prospecting by the usual slow and toilsome process of sinking shafts and running tunnels; a deep cañon from 400 to 600 feet in depth, with an almost perpendicular wall, bisecting at right angles these wonderful silver-leads for many miles. The miner can stand at the bottom of the cañon and see his mine as well and clearly defined, as well as its body of carrying ore, for 500 feet in depth, (from the top where it is cut by the cañon,) as he could if he had a shaft to that depth on his mine.

SAN DIEGO COUNTY.

The principal mines of this county consist of gold-bearing quartz-ledges in Julian and Banner districts, about sixty miles south and east of San Diego. They were discovered in February, 1870; and although there was an "excitement" in the first instance, it rapidly subsided on account of the prejudice existing among most Californians against the "lower country." The formation is slate, sparsely interspersed with granite, and the veins run northeast and southwest. The veins are unusually numerous, though, as a general thing, small. The auriferous belt is about four miles wide and ten long, running northeast and southwest. The most prominent among the many mines that have been worked up to the present time are the Chariot (Mill and Mining Company,) Ready Relief, Stonewall Jackson, Owens, Helvetia, &c. The Chariot Mill and Mining Company has been incorporated in San Francisco, and the Owens and Mammoth Tunnel have been incorporated in San Diego.

On the Chariot mine, the main shaft is down about 150 feet, and is connected by an air-shaft to the 140-foot level. The lode is from 3 to 15 feet wide, the rock of which pays from $75 to $250 per ton in free gold. The company has a five-stamp mill about four miles from the mine. For several months this mine is said to have yielded on an average $1,000 per day net profit to the owners, of whom there were but three.

The Ready Relief mine, situated four miles east of Julian City, has been opened to a depth of 150 to 200 feet. It shows a five-foot ledge of rock, paying from $50 to $100 per ton; worked by water-power, with a 5-stamp mill.

The Helvetia has been opened to a depth of 250 feet, has a 3-foot ledge, and is about to erect machinery. The rock is said to average $28 to $32 per ton.

The Stonewall is located at the foot of the Cuyamaca Peaks, seven and a half miles from Julian City. The ledge runs from 5 to 26 feet in width, at a pitch of 70° to the west. Hanging-wall, slate; foot-wall, granite. The walls average 12 feet apart. This entire space is good pay-ore, except at times small strata of "horse," which is a conglomerate of slate, granite, and quartz. Notwithstanding this, the Stonewall Company runs everything through the stamps and finds it profitable. The shipments of bullion are about $10,000 per month, at a cost of $2,000 per month. The facilities of machinery and convenience of wood, timber, lumber, &c., make the actual cost of working this mine a mere trifle, as no blasting has yet been done or is likely to be required. The shaft has been continued to a depth of 140 feet, and a level each way runs 150 feet. The width of the ledge continues with rock a little harder and the gold a little coarser. The mill is a new 10-stamp mill. The building is 60 by 100 feet, and is so situated that when the rock is dumped from the mine no handling is required from thence to the battery. The engine is 40 horse-power, and a boiler capacity sufficient to run a 20-stamp mill. The superintendent states that $3-rock can be run at a profit.

The Owens mine, near Julian City, has been developed to a depth of between 300 and 400 feet. The ledge runs from 1 to 6 feet wide, at a depth of 300 feet. This mine is now being sunk to a depth of 600 feet, and in the meanwhile levels and stopes will be opened when it is found necessary. The rock averages $75 per ton, at the depth of 275 feet; the rock now prospects on the lower level $75 per ton. A new ledge has been discovered which is likely to run into the original.

The Tom Scott, Eureka, California, and other mines, though not as fully developed as those above named, are all of promising character.

The San Diego Union of December 21, 1873, gives the following account of the Japa mines, situated near the line of Lower California:

> The mines are supposed to be on the summit of the range of mountains extending southeast from Julian, in this county, into Lower California, and the altitude of the camp is estimated to be about 5,000 feet above the level of the sea. Japa is distant about one hundred miles from San Diego, a little south of east. The road diverges from the Yuma stage-road, about sixty miles from this city, and from that point there is a continuous ascent into the mountains. The first diggings were struck at the point known as Japa, but better placers were found at Tres Piños, three miles distant, and the entire population is now concentrated at the latter point. There is a small running stream at Japa, and dirt has been hauled thither to be washed, but the expense of hauling takes the bulk of the profits. These mines are as near to Julian City as to San Diego. They are forty miles southeast of Milquatay, and forty miles north of San Rafael, in Lower California. A large gulch runs through the mining sections, and into this debouch several smaller gulches. In these latter the gold is found. In the large gulch, wells have been sunk to obtain water for washing in the rockers. The gold-bearing stratum is red sand and granite gravel. The whole face of the country is covered with decomposed quartz, but no gold-bearing quartz has yet been found. Preparations are being made for a more extended exploration of the country.
>
> Industrious men can earn fair wages in these placers. All the washing must be done by rockers, as there is not water enough to run sluices or toms. The water is hoisted from wells. Two men are required for each rocker, one to hoist water and one to rock and feed dirt. The Mexicans are making from one dollar to a dollar and a half a day by their process of working. The Americans have made reservoirs on the small gulches, and are now waiting for more rain to give water for washing. It costs $1.50 per load to haul dirt two or three miles to water.
>
> The best diggings in the whole of that section have been found on the *mesa* three or four miles above the gulches. Four men have taken up claims there, and have a bed of red sand four feet in depth to operate upon. They have sunk a well, and have obtained four feet of water at a depth of fourteen feet; this gives them all they want to wash. A prospect-shaft was sunk at Tres Piños to the bed-rock, which was reached in twenty-two feet, when large bowlders were struck. On the bed-rock a prospect of two or three cents to the pan was obtained. The water came in so fast that operations were abandoned. In the small gulches, when the bed-rock is reached, small crevices are found full of a very tenacious, grayish-colored clay, and these crevices are always rich—real "pockets." Beyond these "pockets" the average of the diggings would be from one to three dollars a day to the man.
>
> The country is well wooded, pine predominating. Game is plenty, deer being abundant and venison cheap. Beef is also very cheap, selling at eight cents a pound.

SAN BERNARDINO COUNTY.

This is the largest county in the State, containing 10,000,000 acres. About three-fourths is barren desert and the balance fertile valleys and rugged mountains. The mountainous portion contains many mining districts which in the great quartz excitement of 1862 attracted the attention of adventurous prospectors and miners; but, with few exceptions, these districts have passed into obscurity on account of their remoteness from the lines of travel and their almost inaccessible situation. Among the districts which have survived, and in which active operations are now progressing, are Holcombe Valley and Bear Valley. Recent discoveries in these districts are now attracting the attention of mining operators. In the latter portion of the year 1873 some large ledges of extraordinary richness were discovered in the southern portion of the county, near the San Diego line, at a place called Palm Springs. These ledges are found in slate and granite, and prospect very high in gold. The Palm Consolidated Mining Company, consisting of Messrs. Buell, Bateman, and other well-known mining operators, is proceeding energetically in the development of the district.

Holcombe Valley district.—This district is thirty-five miles distant from the town of San Bernardino and one hundred and thirty miles from Los Angeles. The elevation is between 7,000 and 8,000 feet. The Southern Pacific Railroad, when completed, will pass within twenty-five miles of the principal mines, which are owned by an English company, and are at present being worked under the superintendency of Mr. John Haley. This property is incorporated in London under the name of the Holcombe Valley Gold Mines, limited, and consists of seven parallel veins containing 1,200 linear feet each. The chief of these are the Olio, Mammoth, and San Bernardino lodes. There is also a gravel-deposit or flat of 140 acres adjoining and immediately below the mines, to all of which the company has secured a United States patent. Both the ledges and the gravel-flat have been worked pretty extensively in past years, yielding a large amount of gold. The principal work done by the present company is on the Mammoth lode. Two incline shafts, 320 feet apart, have been sunk on this lode, one to the depth of 170 feet, and the other 106 feet. From the 170-foot incline, at a depth of 120 feet, levels have been started each way. The one north toward the 106-foot incline is in 117 feet, showing a 2½-foot ledge of ore, valued at $15 to $40 per ton. The level running south has been driven 45 feet in average ore. The former owners of the property had stoped out about 40 feet of the surface of this lode between the two inclines, and had also sunk on the Olio to the depth of 175 feet, and on the San Bernardino to the depth of 100 feet, from both of which, including the Mammoth, they raised several thousand tons of ore varying from $9 to $55 per ton in value, as proved by its treatment in a small 8-stamp mill. This mill, which has sufficient power for ten stamps, has been remodeled; the new company has put in a new and complete 5-stamp battery, and intends to increase it to 10 or 20 stamps the coming summer, as may be required. It is also the intention to open up the gravel-deposit the coming spring. This will be done by pumping the water out of the flat and drifting out and washing the richer stratum overlying the bed-rock, which, in other worked portions of the flat, has been found to be from 4 to 6 feet deep, and to vary in value from 2 to 50 cents to the pan. In 1862 there were from 1,500 to 2,000 miners engaged on the shallower portions of the flat, with good results. The deeper portions, which now form a part of the new company's property, could not be worked with the rude appliances of that day. The gold in the flat is identical in fineness with that taken from the quartz-ledges above, and is evidently a wash from them.

NAPA COUNTY.

It now seems probable that this county, situated on the Coast Range, north of San Francisco Bay, and already celebrated for its valuable mines of quicksilver, will soon contribute something toward the bullion-product of the State. Within the past year ledges of gold and silver bearing quartz, have been discovered on the southeastern slope of the Saint Helena Mountain, distant some four miles from the celebrated watering place, Calistoga, at the head of Napa Valley. These ledges run parallel on a course of 10° west of north, and dip west at an angle of 70°. They are about a quarter of a mile apart, and are situated at an elevation of 2,400 feet above sea-level. The country is well wooded, and an abundant supply of water is available at a convenient mill-site. For a long time it was supposed that the Coast Range was destitute of gold and silver bearing veins, and these ledges, which crop boldly, and are crossed by a well-traveled trail across the mountain, for years escaped the attention of the prospectors and miners, who were incredulous of the existence of gold and silver west of the Sierra Nevada.

These veins, which are of massive proportions, being from 6 to 10 feet in thickness on the surface, can be identified for a space of three miles, cropping out boldly at many points and being easily traceable throughout that entire distance. The prevailing country-rock is porphyry and trachyte, but a heavy band of argillaceous slate constitutes the hanging-wall of the lode, which is separated from it by a thick clay selvage. The vein-matter is composed almost wholly of quartz and ore, the former nearly pure silex of a reddish cast and the latter a blue sulphuret. Numerous assays made of this ore show it to contain from $20 to $100 in gold and silver per ton; the value of these metals being about equal at first, but silver predominating with depth attained. Lots milled have yielded from $23 to $27 per ton. It is a free ore and can be worked up to a close percentage of the fire-assay by the cheapest and simplest methods of reduction in use.

Of the several companies owning on these lodes, two, the Mount Saint Helena and the Calistoga, have been developed; a tunnel, now completed a distance of 100 feet, is being driven in on the vein, the work being still in progress. The inner extremity of this tunnel is 200 feet below the croppings, at which point the lode is about 8 feet in thickness, the whole of it composed of quartz and ore. About 300 tons of good milling ore, removed in the course of excavating the tunnel, are now on the dump, the late additions to this lot, which, it is expected, will mill $26 per ton, being of a much higher grade than that first taken out. Of the material removed in driving the tunnel, nine-tenths have been reserved for crushing. A cross-cutting having lately been made on the 200 foot level, a large body of ore was broken into of a much higher grade than any before encountered.

Dr. Henry De Groot, who visited this county on a tour of inspection of its quicksilver-mines, during the fall of 1873, says of this interest:

> Without going into a detailed description of individual mines, it may be stated here that this ore occurs at intervals throughout almost the entire length of Napa County, the area through which it is distributed being not less than forty or fifty square miles. The most productive district, however, has for its center Mount Saint Helena, an irregular volcanic cone situated in the northern part of the county, and rising abruptly on every side to a height of 3,500 feet. Scattered throughout the foot-hills that encircle, and the lower ranges that flank, this mountain, this cinnabar-field reaches north and east into Lake and westerly into Sonoma County. Here more than a hundred company claims have already been taken up, while the work of prospecting is still actively going on. Some of these claims have a very good and others but an indifferent show of surface ore. In most cases, however, the croppings, or top deposits, are rich, and often very extensive. Upon twenty-five or thirty claims a good deal, and upon about an equal number a moderate amount, of work has been done, the balance being held for speculation, with only enough work performed to keep possession under the local laws. In some instances the claimants have not the means to open their grounds, and would give parties willing to undertake the work a liberal interest for developing them. Several companies have a large force of men employed, and have expended as much as fifteen or twenty thousand dollars, and in a few instances a good deal more, in opening up and improving their mines. The mode of exploration is by open cuts, shafts, and tunnels, the improvements consisting mainly of steam-engines for hoisting, pumping, and blasting purposes, with furnaces, retorts, roads, buildings, &c.
>
> The production of the new mines here ranges from 20 to 200 flasks per month each, only the Redington, at Knoxville, Lake County, opened many years since, yielding more than this. At the Redington, 400 flasks are turned out, and it is the opinion of some that much more might be made were it not the policy of the combination, with which the owners are in league, to restrict production as a means of maintaining the present high prices of quicksilver. It is a fact, however, that the ore here has for some time past been of very low grade, to which cause the curtailed production is no doubt mainly due. Recently ore of better quality has been struck on the 200-foot level of this mine, and as the owners have replaced their old furnace with one of the Knox & Osborne style, larger monthly returns may be looked for hereafter. In this con-

nection it may be remarked that the opinion so generally entertained that the so-called quicksilver combination have conspired to restrict the yield of the mines under their control is most likely erroneous, the falling off in the yield of these mines having been due chiefly to a growing scarcity or a marked depreciation in the quality of their ores, reducing the product of quicksilver at a time when its consumption was being greatly extended. But whatever the cause of the high prices now ruling for that metal, certain it is they have greatly favored the owners of these new mines, they having experienced but little difficulty in getting capital to help outfit and expose them. The ores in this vicinity, though mostly obtained thus far from near the surface, have yielded from two to six per cent. of metal—averaging perhaps 4 per cent. In view of their abundance and the small cost at which they can be mined and reduced, even 1 per cent. ore would leave fair margins for profit. Mining, hauling, and reduction can be done here at a cost of five or six dollars per ton, the country about producing the staples of subsistence in abundance, while wood and water are everywhere in good supply.

Statement of the Helena quartz-mine, Saint Helena district, Napa County, California, reported by W. A. Skidmore.

Name, Saint Helena; owners, Badlam, Hayes & Deane, and others; location, Saint Helena Mountain; course, ten degrees west of north; dip, seventy-two degrees west; length of chimney, 500 feet; thickness, 4 to 6 feet; depth main shaft, none; total length tunnel, 60 feet; country rock, trachyte, and porphyry, with seam of greenstone; vein-matter, gold and silver bearing quartz, freely sulphureted; value, per ton, $20 to $30. Average assays show $25 gold and $12 silver. There were one hundred and fifty tons on dump in September, 1873, and an abundance in sight. No mill yet erected. There is a parallel ledge higher up on slopes of Saint Helena Mountain, but it has not yet been prospected. The existence of a well-defined quartz-vein in the Coast Range of California is a novelty in the history of mining in California. The quartz differs widely from the quartz of the Sierra Nevada, having a granular appearance and a peculiar crystallization.

MARIPOSA COUNTY.

This county, although possessing many quartz-veins outside of the Mariposa grant, has of late years failed to attract the attention of quartz-miners to the extent the merits of its ledges would deserve. Among the prominent mines not within the boundaries of the Grant are the Ferguson, (owned in England,) the Washington, Maxwell Creek, and Hite's Cove. The latter mine is opened by a tunnel 1,400 feet in length and 7 feet by 5 feet in dimensions, which taps the ledge at a depth of 900 feet. This tunnel will be connected with the main shaft, thereby insuring a supply of quartz for many years.

The Washington mine is located near Quartzburgh, about two miles north of Hornitos. The company claims 3,000 feet of a ledge, running northwest by southeast, which pitches south. The ledge varies from 5 to 24 feet in width, and averages about 15 feet thick. There is no visible free gold in the ore. It is highly charged with sulphurets, and pays an average of $10 per ton in the batteries, and the sulphurets, which the company reduces at its own chlorination-works, average $60 per ton. This mine is being developed by two shafts. Hoisting-works, run by steam, command both shafts. The company has a 20-stamp mill on the premises, and runs it night and day, crushing 25 tons every 24 hours, working in mill and mine 45 men regularly.

The only mines in the county which have run with regularity are the Hite's Cove and the Washington.

Catron's mine, at Buckeye, near Hornitos, courses northeast and southwest, and dips 60 degrees southeast. The claim is 300 feet long, and the vein about 3 feet wide. Country rock, granite (?); vein-matter, quartz, yielding about $10 per ton. Depth of main shaft, 60 feet; total length of levels, 100 feet. The quartz is crushed in a small water-power 4-stamp mill.

The Italian mine, owned by Signor Capidonica, at Hornitos, courses north-northeast and south-southwest, and dips 45 degrees southeast. Length of claim, 450 feet; width of vein, 4½ feet; country rock, slate; vein-matter, quartz, worth $18 per ton. Depth of shaft, 100 feet; aggregate length of levels, 90 feet. The mine has a 5-stamp steam-mill.

There is in general use in this county a peculiar concentrator, the invention of Mr. Charles Schofield. These concentrators are said to be remarkable for their efficiency and economy. They are constructed mostly of wood, and consist of two or more hopper-shaped boxes placed over a tank with several compartments, and as many small sluices, three or four inches in width and about 60 feet in length, leading from the above tank to another below, which latter is divided into two compartments. A few inches above the real bottom of the boxes first above mentioned is a false bottom, composed of a screen of perforated sheet-iron, beneath which is inserted a pipe conveying clean water from a tank above, with at least 10 or 12 feet pressure. A portion of this water is let off through discharge-cocks on the opposite side of the machine, and the remainder forced up through the screen with sufficient pressure to prevent any light and worthless matter from passing downward through the screen against this upward current. The pulp is conveyed from the battery through a sluice into the top of the first box, and all the coarse, heavy sand, and most of the sulphurets, pass down through the screen and out through the discharge-cocks into the tank below; but all sand and sulphurets which are too fine and light to resist the upward current of water in the first box pass on into the next, and go through the same trial again, under diminished pressure, which results in abstracting a finer quality of sand and the remainder of the sulphurets. The quicksilver and amalgam stop in the bottom of the first box. When one or more apartments of the tank beneath the boxes are filled with sand, plugs are removed which let the sand flow into the small sluices, and a small stream of water is applied, which, with the sand, forms gentle undulations, or sand-riffs, which continually work the sulphurets down to the bottom, but carry the sand out at the end of the sluice over the lower tank. When all is out of the upper tank that will conveniently flow out, the plugs are replaced and the stream of clear water continued until the sand is all washed out of the sluices; the sulphurets are then carried by a stronger current and let out through a gate in the side of the sluice into the tank below.

On the Mariposa estate, little has been done during the year except to prosecute the scheme of a deep adit, entering at the Merced River, near the Ophir Mills. This adit is run with the aid of Burleigh machine-drills and compressed air. It follows the course of the Linda or Pine-tree vein, but keeps outside of the vein in the slate of the country-rock, which can be more cheaply excavated. Several encouraging discoveries have been made on the surface in various parts of the Grant. In the deep adit no cross-cutting will be done to expose the vein until 1,000 feet have been completed—probably early in the fall of 1874.

List of principal mines on Mariposa estate, Mariposa County, California.—Reported by James Dolan.

Name.	Owner.	Location.	Course.	Dip.	Dimensions.		Development.		Country rock.	Vein-matter.	Average value per ton.	Per cent. sulphurets per ton.*	Remarks.
					Length.	Thickness.	Depth of main shaft.	Total length of drifts.					
				°	*Feet.*	*Feet.*	*Feet.*	*Feet.*					
Pine Tree....	Mariposa Mining Company.	Bear Valley...	N. E. and S. W..	65 E..	1,700	7	1,600	......	Porphyritic greenstone and talcose slate.	Sulphureted quartz and free gold.	$8	....	
Josephine...	Mariposa Mining Company.	Bear Valley...	N. E. and S. W..	65 E..	1,000	7	600	......	Porphyritic greenstone and micacious slate.	Sulphureted quartz and free gold.	8	....	
Mount Ophir.	Mariposa Mining Company.	Mount Ophir..	N. E. and S. W..	65 E..	300	4	250	......	Greenstone and talcose slate.	Sulphureted quartz and free gold.	8	....	
Princeton	Mariposa Mining Company.	Princeton.....	N. E. and S. W..	65 E..	1,200	5	900	......	Black slate on both walls.	Sulphureted quartz and free gold.	16	....	Free gold.
Mariposa.....	Mariposa Mining Company.	Mariposa	N. E. and S. W..	65 E..	800	5	400	......	Porphyry and slate.	Sulphureted quartz and free gold.	14	....	Contains rich pockets of free gold.
Buckeye.....	Mariposa Mining Company.	Betw'n Princeton and Mariposa.	N. E. and S. W..	65 E..	......	1 to 2	160	300	Granite	Free gold	40	....	Undeveloped, with promising prospect.

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* Sulphurets have not been saved. The proportion of sulphurets has diminished with depth.

List of mills in Mariposa County, California.—Reported by James Dolan and Charles Schofield.

Name of mill and owner.	Location.	Power—steam or water.	Horse-power, engine.	Number of stamps.	Weight of stamps.	Number of drops per minute.	Height of drop.	Number and kind of pans.	Number and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours.	Crushing capacity of mill per 24 hours.	Loss of mercury per ton.	Cost of treatment per ton.	Running time, months.
					Lb.		*Inches.*				*Cds.*	*tons*			
Benton, Mariposa Mining Company.	Merced River.	Water.	....	84	650	60	8	Continually changing	Six Hendy....	....	....	84	.....	....	These mills have not been running regularly during the past year.
Mount Ophir, Mariposa Mining Company.	Mount Ophir ...	Steam.	....	24	650	60	8	Two pans and Arrastras.	None	....	....	24			
Princeton, Mariposa Mining Company.	Princeton.......	Steam.	....	24	650	60	8 to 9	None............	....do	....	....	30			
Mariposa, Mariposa Mining Company.	Mariposa	Steam.	....	48	650	60	8 to 9	Four Knox	....do	....	....	48			
John H. Neal's mill	Buckeye, near Mariposa.	Water.	....	4	600	60	6	One Arrastra.........	One Schofield.	$2,500	....	4	Very little.	..	Six months.
Catron's mill.............		Steam.	10	4	600	60	6½	....	....do	2,000	1½	4			Eight or ten mos.
Dan Brien's mill		Water.	....	4	600	65	6½	One Arrastra.........	....do	2,000	....	4½			Six months.
Italian mill	Hornitos........	Steam.	12	5	750	60	6	None............	... do	4,000	1½	7	....	$3 50	Two months.
Washington mill	....do	Steam.	75	20	700	55	8	....do...........	Two Buddles.	....	....	20	....	......	Twelve months.
Hunter's Valley mill........	Hunter's Valley.	Steam.	....	28	650	70	11	....	....	....	....	50	....	......	

NOTE.—The Hunter's Valley mill has a single discharge; four mortars with four stamps, and two mortars with six stamps; screens, Russia punched, No. 6. The rock crushed is "easy" quartz, and the efficiency of the stamps is 2.21 tons per horse-power per day in the four-stamp mortars, and 2.32 tons per horse-power per day in the six-stamp mortars. Other conditions are apparently equal; hence we may conclude that twelve stamps do better work in two mortars than in three. The usual number of stamps to one mortar, however, is five.—R. W. R.

TUOLUMNE AND STANISLAUS COUNTIES.

The mining interests of Tuolumne County comprise both quartz and gravel. The most extensive gravel-claims are situated beneath the basaltic capping of Table Mountain, in the vicinity of Jamestown and Jeffersonville. Here mining is prosecuted by means of tunneling under the capping and drifting on the channel. The gravel extracted is washed in long sluices, or treated in a machine known as the Cox pan, which is fully described in former reports. The quartz-mines of the county have been neglected for several years, but within the past year several mines of repute have passed, after years of idleness, into the hands of new owners, who are energetically prosecuting work upon them. Among this class we may note the Patterson, Soulsby, Rawhide, and others, while many others of equally promising character are worked by individual owners. Owing to the reluctance manifested by mine-owners in furnishing information as to their operations during the year, I am unable to give full details of the condition of the county.

The Patterson mine, which had been idle for nearly five years, recently passed into the hands of Mr. J. J. Corrigan, who immediately commenced developing the property, and, within the period of a few months, has brought it from a position of comparative obscurity to that of one of the leading mines of the county. This mine is situated five or six miles west of Sonora.

The ledge runs northwest by southeast, and pitches to the northeast; the vein is from 4 to 50 feet in width, and both the hanging and foot walls are well defined. The extent of the location is about 1,900 feet, and is developed by two tunnels run in on the level of the mill, to which the rock is brought in cars. One of these tunnels is run in on the vein, and is now in 450 feet, and 131 feet from the surface. The other tunnel, (No. 2,) starting at a point 150 feet south of tunnel No. 1, is now in 240 feet, about 100 feet of which is upon the ledge. The property is under the management of Mr. D. T. Hughes.

Mr. L. P. McCarty, of the Mining and Scientific Press, who visited the property in July, says:

> The character of this rock in this mine is peculiar. It consists of quartz, slate, dolomite and calcareous matter; is highly sulphureted, and everything between the walls pays something. The rock is generally low-grade, but as the vein is large, easily taken out and reduced, it will undoubtedly pay a handsome profit; the rock in the past has run from $4 to $20 per ton. This rock will average about $10 per ton without counting the sulphurets. This company have erected a fine 20-stamp mill, which is run by water-power. This mill has a capacity of crushing thirty tons per day, (twenty-four hours.) The amalgamation is done by copper plates, silver-plated, and the ordinary riffle. The sulphurets are estimated to go about $100 per ton.

The Rawhide quartz-mine now bears another name, and is owned by parties in London and New York. It is located at Rawhide ranch, on the west side of Table Mountain, and distant about five miles west from Sonora, on a ledge running northwest by southeast, which dips to the northeast, and is about 1,700 feet in length. The claim has been lying idle for over six years, for reasons best known to its owners; but they have now determined to thoroughly open it up. The main shaft was sunk to a depth of 280 feet by the former owners. The company own powerful hoisting and pumping works and a first-class 20-stamp mill, capable of crushing 30 tons per day. This mine was for a long period the leading quartz-mine of the county.

On the Soulsby and the Buchanan, each of which has a brilliant record, work has been resumed within the year. The Confidence mine, in the granite formation east of Sonora, has suspended operations, owing, it is said, to the exhaustion of the pay-shoot. This mine, during 1871, shipped from $28,000 to $32,000 per month, and its present condition is a noted example of the uncertainty of quartz-mining, though it illustrates, perhaps, rather the liability of owners to discouragement than the liability of mines to exhaustion.

To what was said in my last report concerning the App mine, the following may be added, from a manuscript report of Mr. R. B. Noyes :

> In the App mine the same relative developments have been proven as in leading mines on the mother lode. The same poor zone has been passed through, and at the depth of 650 feet a shoot of ore has been cut which affords promising indications of a large, permanent, and rich body of ore underlying it. Taking, therefore, into consideration the resemblance of the ores taken from the App and Heslep mines with those from the mines of Calaveras and Amador Counties; the existence of the same characteristics of formation and vein-matter; the increasing grade of the ores with the increased depth of sinking; the great width of the veins as at present determined in the lowest levels; the low cost of mining and milling the ores; the ample facilities for raising the ores, transporting by tramways to the respective mills; the well-arranged reduction-works of forty stamps; the low price of water-power, and the cost of extraction and reduction should not much exceed $4 per ton.
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> An examination of the work done in the course of the development of the Heslep mine shows that the dead-work heretofore obliged to be done is no longer possible, since the bottom of the shaft is in its full width and length in pay-ore, and the cost, therefore, of sinking is repaid from the value of the ore extracted. The lowest level at the depth of 270 feet which has been run south in the pay-shoot 130 feet shows a large ledge of good pay-ore;* its average width being at least 10 feet and its milling value about $8.75 per ton; while this single level gives reserves of several thousand tons of ore of this character. The average workings upon this property do not at any point exceed 200 feet in length, consequently there remains much of the ground entirely unexplored, and the later and natural developments at the surface seem to indicate that the most valuable ore-deposit lies south of the present workings, which can be determined at a small cost by the extension of the present drifts from the shaft. The surface indications also show that there are ore-shoots lying north of the shaft, but their extent and value remain undetermined by reason of a want of systematic, thorough exploration, which increased pecuniary means will afford. While the grade of the ore of this mine is low, yet at certain points rich deposits have been opened, which have not seemed in any measure to render barren the immediate vein, as frequently occurs in what are known as "spotted mines," but have added to the average value of the whole body largely. The character of the ore is so regular, evidently increasing with every newly-opened level in depth, the walls of the vein are so perfect and consistent in their formation, the width of the vein is so great, all of these facts taken into consideration give to this mine a promise of undoubted permanence and future wealth.
>
> Since the early part of 1869 the shaft of the App mine has been carried down to a depth of 800 feet. From the 350-foot level to the one opened at 650 feet, the zone of ore was found to be comparatively poor in its quality, and the vein variable in width. At the depth of 650 feet a level was run north upon the vein, which, at a distance of 80 feet from the shaft, encountered the edge of a pay-shoot pitching north, and along which the level was continued 112 feet to its northern edge, thereby opening a shoot of pay-ore 112 feet long and 8½ feet wide, and of the average value, along the level, of $14 per ton, but in upraising with the stopes for ore its value decreased in a few feet to $10 per ton, showing that this level was cutting the top of the ore-shoot. This level was again continued 12 feet beyond the northern edge of the first shoot, and there encountered a second shoot 9 feet thick, the rock from which looked exceedingly well. At the depth of 708 feet another level was run to the north, and at the distance of 85 feet encountered the shoot, and the extension of the level along the course of the shoot gives promise of valuable reserves of ore. The second pay-shoot encountered in the 650-foot level will undoubtedly be found in the extension of the 708-foot level, and the character of the rock already determined gives promise of permanence and richness. An extension of the level at the depth of 770 feet, which has already been driven 55 feet north, will, without doubt, develop these shoots in still greater permanence of vein, strength, and better quality. At the depth of 650 feet a level has been driven 110 feet south from the shaft in vein-matter, but no cross-cut has been made across the vein to determine its true character. It is believed, however, that a cross-cut run from the end of this level will develop a well-known pay-shoot, which at the surface shows rich ore. Six other shoots of pay-ore are known to exist toward the north end of the mine, though the want of funds to do dead-work has prevented their

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* The body of pay-ore is 165 feet long.

proper development; but this mine is now in a good condition for such development, and the prompt extension of the present levels ought, in a short period, to develop new and valuable ore-bodies.

The reserves of ore at present determined to exist, and their known value, the fair promises of increasing values in the future, the almost certain permanence of the vein formation, give to these properties a well-ascertained present value, and I think a prospective value in the immediate future, equal to any of the prominent mines now being successfully worked upon the same "great lode." With the present ample hoisting-machinery, completed tramways, well-arranged mills and milling-machinery, and the ample plant at hand, and the continuance of an energetic prosecution of the work of development below and along the present opened levels, a thorough prospecting by drifts and cross-cuts along the course of the vein for other shoots of ore which are known to exist along the croppings on the surface, and these consolidated properties cannot fail to yield handsome returns of surplus profits.

The cost of extracting and reducing these ores should not exceed $4 per ton under full work; the capacity of the two mills (forty stamps) is not less than fifty tons of ore per day, making the daily expenses say $200 per day; the average present yield of the ore from both mines combined can be safely placed at $9 per ton, which will give a daily return of $450; less working expenses, as above, $200, and there is a daily net profit of $250, or equal to $7,500 per month. This result may be said to be "in sight," while an improved value which may be anticipated by the developments of new and lower levels can be safely relied upon to give much larger returns in the near future.

No notice is taken in this report of the value of the sulphurets contained in the ore of the Heslep mine. By an assay made at the Nevada metallurgical works in San Francisco, this ore was found to contain 2½ per cent. of sulphurets, which assayed $142.50 per ton, making the yield in sulphurets $3.56 per ton of ore. But the subject of this assay was one of more than ordinary richness. As concentrated at the mill, the sulphurets assay $40 per ton, which is equal to $1 per ton of ore, which, at least, must be added to the assumed value of the ore as given by Mr. Noyes.

STANISLAUS COUNTY.

This county is situated west of Calaveras and Tuolumne Counties, and its eastern portion partakes of many of the characteristics of the same. The foot-hill country contains rolling hills permeated with veins of quartz, while somewhat higher we find ranges and basins of auriferous gravel. One of the most extensive properties of this character in the southern mining region is that of the La Grange Ditch and Hydraulic Mining Company, fully described in the report of 1873. The company owns a ditch seventeen miles in length, of a capacity to carry 3,500 inches of water. Its supply of water is taken from the Tuolumne River, at the head of Indian Bar. No dam is used. The ditch starts at a point on the river where a deep pool or eddy exists. The first 3,000 feet, after the water leaves the river, it is carried in a sunken flume below high-water mark; thence through a cement ditch for a fourth of a mile. The cañon through which it is carried, after leaving the river, is one of the roughest in this State. In some places a stone wall is built to heights varying from 50 to 75 feet. In one place this company have a flume one and one-fourth miles in length. In addition to a water-privilege which cost originally about $250,000 and employed 1,000 men ten months to complete, the company owns four different sets of hydraulic claims covering an area of about 900 acres. Since the completion of the ditch the company has paid several dividends, aggregating $12,500; and the enterprise has demonstrated the feasibility of profitably working the ranges of low gravel-hills so common in this and other counties of the eastern rim of the San Joaquin Valley.

CALAVERAS COUNTY.

This county has 26 mills, which crushed 37,105 tons of quartz during the year. There are several mining-districts within its limits enjoying a fair share of prosperity. Among these are West Point district, where are now being opened several quartz-mines destined ere long to contribute a large addition to the gold product of the State. Among these may be noted the Sanderson, Zacatera, Wolverine, Mosquito, Ohio, Consolidated, and Prussian Hill. Although sets of blanks were sent to these and other mines of the district, no returns were received. Various reasons were given for the refusal, the common one being that the district was not sufficiently developed to make a good exhibit. This reluctance to give information is much to be regretted, since the Commissioner's report is frequently consulted by parties seeking information on the points provided for in the various blank-headings.

Mr. John Rathgeb, of San Andreas, has again placed me under obligations by a full and careful report of the mining interests of his dis-

Statement showing operations of leading mines of San Andreas mining district, Calaveras County, California, for the year 1873, reported by John Rathgeb.

Mine.	Owners.	Total number tons raised.	Total number tons worked.	Average yield, per ton.	Number of stamps employed.	Cost of mining, per ton.	Cost of milling, per ton.	Company or custom mill.	Miners' wages per day.	Number of miners employed.	Remarks.
Thorpe	Captain Thorpe & Sons.	500	300	$7 00 to $10 00	5	$3 00	$1 50	Co	$3 00 and $2 50	4	Hoisting and pumping by water-power; 24-foot overshot water-wheel.
Hudson	English Company	200				6 00			3 00	8	Hoisting and pumping by hurdy-gurdy water-wheel 5 feet in diameter.
Garnet	Lloyd Brothers	1,500	1,500	8 00 to 9 00	5	2 50		Co	3 00 and 2 50	12	Hoisting and milling by water-power; 32-foot overshot wheel; Mexican arrastra and sluices.
Everlasting	Andrew Seifford	800	None			4 00			3 00 and 2 50	12	Hoisting-works by steam; mill in contemplation; 10-stamp quartz-mill (by steam) and chlorination-works.
Union	John Rathgeb	100	None			4 00		Co	3 00 and 2 50	6	Hoisting by steam; stamp-works run by water-power; a 7½-foot hurdy-gurdy wheel, 103-foot fall.
Lachapelle	Lachapelle & Barnett.	200	10	10 00		2 50			2 50	4	Mexican arrastra.
Pioneer Chief.	B. K. Thorne	500	10	7 50		3 50			2 50	4	Hoisting done by horse-power.

List of producing mines in San Andreas district, Calaveras County, California, reported by John Rathgeb.

Name of mine.	Owner.	Location.	Course.	Dip.	Dimensions.		Development.		Country-rock.	Vein-matter.	Average value per ton.	Per cent. of sulphurets per ton.	Number of tons extracted and milled during the year, July 1, 1872, to July 1, 1873.
					Length.	Average thickness.	Depth of main shaft.	Total length of drifts.					
					Feet.	*Feet.*	*Feet.*	*Feet.*					
Hudson mine	English Company.	Central Hill.......	N. W. and S. E.	E.	1, 500	5	150	50	Granite	Quartz; streaks of sulphurets.	....	....	No quartz-mill.
Thorpe's mine	Capt. Thorpe & Sons.	Fourth Crossing ..	N. and S.	E.	1, 000	5	75	160	Siliceous, and talc slate.	Quartz; talcose and siliceous slate; cubical sulphurets.	$7–10 00	10	300 tons milled.
Beckman's mine ...	Judge Beckman..	....do	N. N. W. and S. S. E.	E.	1, 400	3	{1=60 {1=50	} 60	Slate; siliceous....	Quartz; siliceous slate; cubical sulphurets.	20 00	10	200 tons on dump.
Lachapelle mine...	L. Lachapelle & Barrett.	San Andreas......	N. and S.	E.	1, 500	5	{1=40 {1=45	} ...	Slate and granite..	Quartz; pyrites in seams.	10 00	10	10 tons milled.
Everlasting mine..	Andrew Seifford ..	....do	N. W. and S. E.	E.	3, 000	13	175	90	Granite west and greenstone east.	Quartz; siliceous slates; cubical sulphurets.	7 00	20	10 tons milled.
Pioneer Chief mine.	B. K. Thorne......	....do	N. W. and S. E.	E.	3, 000	5	300	.....	Granite west and greenstone east.	Quartz; talcose slate; sulphurets.	7 50	5	10 tons milled.
Union mine........	H. Rathgeb	Lower Calaveritas.	N. 28½° W.	E.	2, 400	5	160	200	Granitic..........	Quartz; siliceous slate.	15 00	2	800 tons on dump.
Rathgeb mine	....do	....do	N. and S.	E.	2, 000	4	70	150	Slate east and granite west.	Quartz; talcose slate	7 00	5	600 tons on dump.
Garnet mine	Lloyd Brothers....	San Andreas	N. W. and S. E.	....	2, 000	5	42	600	Slate and granite..	Cement gravel	8–9 00	....	1, 500 tons milled.
Shot-Gun mine	....do	Cherokee	N. W. and S. E.	E.	1, 500	8	40	20	Slate and granite ..	Quartz; free gold, fine.	10 00	20	Sulphurets worth $200 per ton; 200 tons on dump.
Anton mine........	Anton Illish	Lower Calaveritas	N. W. and S. E	E.	800	6	50	35	Granitic...........	Quartz; free gold, coarse and fine.	12 00	5	100 tons on dump.

REMARKS.—The Garnet mine is an old-river channel, 300 feet wide; pay-gravel 5 feet deep; two-thirds of the contents of pay-streak are refuse bowlders.

List of mills in San Andreas district, Calaveras County, California, reported by John Rathgeb.

Name of mill and owner.	Location.	Power—steam or water.	Number of stamps.	Weight of stamps—pounds.	Number of drops per minute.	Height of drop—inches.	Cost of mill.	Crushing capacity of mill per 24 hours—tons.
Thorpe's mill, (Thorpe & Sons)	Fourth Crossing ..	Water, 24 feet over-shot.	5	530	75	9	$2,000	5
Demarest Mill, (Demarest) ...	Dry Creek	Water, 32 feet over-shot.	10	600	60	9	4,000	10
Garnet Mill, (Lloyd Bros)	San Andreas	...do	5	600	60	10	5,000	5
Irwine Mill, (William Irwine)	....do	...do	5	500	60	10	3,000	4
McKee Mill	Lower Calaveritas.	Water, 36 feet over-shot.	10	450	65	10	4,000	8
J. Rathgeb's mill	....do	Water, 7½ feet hurdy-gurdy, 103 feet fall.	10	700	70	8	6,000	12-15

REMARKS.—The ores all contain more or less sulphurets, but in none of the mills have they been separated from the ore or pulp. Thorpe's mill was running six or eight months; cost of treatment per ton $1.50. The Garnet Mill was running ten months. None of these mills have concentrators. The Garnet has an arrastra, and the Rathgeb three of Bann & Guyot's pans.

Mr. J. Rathgeb furnishes the following items concerning the gravel mines of San Andreas district:

The Garnet cement gravel claim is owned by the Messrs. Lloyd, in San Andreas. Length of claim, 2,000 feet by 600 feet in width; course, southeast to northwest; width of channel of gold bearing cement gravel, 300 feet; depth of pay-stratum, 5 feet; channel worked, 1,000 feet in length by 250 feet average width; number of miners employed, 12; quantity of pay or wash-cement gravel drifted per man, 12 tubs full, (200 pounds net per tub;) average per day for ten men, 8 tons wash-gravel and 16 tons refuse, (large bowlders left in worked ground;) ground worked since twelve months, 200 feet in length, 300 in width, 4 to 5 feet in height. Hoisting is done by a 32 foot over-shot water-wheel; the same power drives a heavy Mexican arrastra, and the water from the over-shot wheel is used to wash the crushed cement through sluices. Drifters are paid $3 and $2.50, car-men $1.50, surface-hands $1.50 per day. This claim yields regularly nearly $1,400 per month, gross, in fine and coarse gold. The bed-rock is blue, yellow, and gray slate, worn smooth. Amount of water used in this claim, 20 inches; depth of shaft, 42 feet; cost of water, (for day shift of ten hours,) $10.50 per week. Composition of diluvial deposit from surface down, lava or gray and white sedimentary cement formation of fine and coarse grain; the pay-streak above bed-rock is dark and gray quartz and granite bowlders, cemented with ferruginous sand.

On the same channel, two miles west, is the Rising Star, a cement-gravel claim, owned by Dyas & Co., in Log-cabin district, Central Hill. Amount of water used in washing in sluices, 25 inches; cost of water per day of twelve hours, $7.50; two air-shafts, 95 and 120 feet deep; tunnel run into the channel, 1,200 feet long. Eight years' labor were required, after commencing this claim, to reach the channel. The expenditure during this period was $10,000. Width of channel, 150 feet; thickness of pay-gravel in the channel, 7 feet; average yield, $8 per car-load of 1,500 net pounds; quantity of refuse bowlders left behind, about ⅝ of the gross amount, in large, white, and blue quartz bowlders, worn smooth, coated with iron sulphurets. The pay-cement is fine quartz sand; small worn quartz pebbles, blue and white, cemented by iron-oxide and sulphurets; pieces of blue and gray slate and granite; black sand of hematite and magnetite. Course of channel, southwest and northeast. Bed-rock, blue granite, with reefs of blue slate.

The following statement is presented by Mr. W. Aug. Knapp, in relation to improvements upon the Ohio Consolidated mine, West Point district:

A shaft has been sunk upon the middle vein for hoisting purposes and pumping, the power being an over-shot wheel of 30 feet in diameter, 4 feet face, supplied by water from a ditch above. This wheel will answer to attach and drive an 8-stamp mill as well. Connected with this shaft at a depth of about 130 feet, there is a drain-tunnel 330 feet in length, saving the hoisting of water above the tunnel, and at the depth of 150 feet there is a cross-drift of about 120 feet to the east vein; also, a raise 32 feet high. North stope open 80 feet, which prospects over $50 per ton. In the cross-drift of east vein a large body of ore has been reached 80 feet below where it has been worked from above, and in consequence of want of ventilation and to secure greater and better facilities for working, it was deemed advisable to sink another and more substantial working-shaft on this vein. This necessitated the purchase of a steam-engine and boiler, together with permanent hoisting gear, &c.; also, the building of a house over the same for protection against the weather, storage of tools, dry wood for the engine, &c.

The shaft on this vein has been sunk to a depth of about 150 feet thus far, and the connection with the lower works have been made, all being done in the most substantial manner, timbered solid throughout, being some 4½ by 10 feet in the clear, showing a well-defined ledge of an average thickness of nearly 2 feet all the way down.

These recent improvements have all been made with a view to permanency, and have all been constructed on the most economical principle it was practicable to pursue. It is designed also to erect an 8-stamp battery as soon as the weather will permit, thus enabling the company to crush its own ores, particularly the low grade, of which the present shaft will open up a very large amount.

The Wolverine mine, situated in the same vicinity, is about three miles northwest of Railroad Flat. This company has acquired by purchase and location a series of ledges 2,200 feet in extent. The mine is developed by one principal incline shaft, now down 300 feet on the incline of the ledge, at which point the ledge averages 3½ feet thick. Above the 200-foot level it is about 2½ feet thick, and at some points below that level it runs to 6 feet in thickness. The previous development of this mine was by another incline shaft, sunk to a depth of 90 feet, and a tunnel that was run in on the ledge, 208 feet, cutting what is known in this mine as their south chimney. This company runs its hoisting-works by a 35 horse-power steam-engine. The same engine also runs the mill, which is of ten stamps, and has a capacity of 16 tons every twenty-four hours. The rock now being extracted is from between the 200 and 300-foot levels, the pay of which averages about $20 per ton, running from $18 to $27 per ton. In June this company crushed 228 tons of ore, which yielded $5,080, netting a dividend of about $2,000 to the corporation. It employs in all departments some forty men.

There are a number of gold mines worked in this locality. The district has been very much neglected for some years in point of capital, and the mines have been chiefly worked by Mexicans down to the water-level, and hard formation of the country rock. They have generally found good pay to this distance, and seldom send any ore to the custom-mills that does not yield from $20 to $30 per ton.

The Sanderson mine is at present attracting more attention and making a better showing than any other mine in the county. The rock being obtained from it is exceedingly rich, free gold being diffused all through the ore. This rock is extracted from the north level, at a depth of 200 feet, and is estimated by good judges to be worth $40 per ton. The level has been run about 50 feet in this character of rock. The vein averages about 2 feet in thickness, the quartz being of a dark blue color, carrying iron and galena sulphurets, in addition to free gold. It is estimated that there is money enough in sight to pay $3 for every dollar the mine has cost; and yet prospecting the ledge has scarcely commenced. The mine has steam hoisting-works and a fine Cornish pump, but no mill. The owners propose to sink the shaft 300 feet deeper—the sinking to be done by the use of compressed air—and when this is completed, a mill will then be erected to work the ore. The Sanderson is regarded by its owners as the coming mine of Calaveras County, and others who have inspected it speak very highly of its condition and prospects.

The Garibaldi is situated near Robinson's Ferry, and is now turning out large quantities of high-grade ore. It is worked through a tunnel, 152 feet long, cutting two bodies of ore aggregating 13 feet in width, parted by a 6-inch clay seam, the head wall having a gouge of 12 inches, soft and wet. Average ore from the east vein yields over $30 per ton, free gold. Water-power is abundant and cheap, the Stanislaus River crossing the vein at each end of the claim.

In the absence of any direct information from the Gwin mine, I extract the following from the Calaveras Chronicle:

> In noting the progress of mineral development throughout the county, attention is naturally directed to the well-known Gwin mine, in Lower Rich Gulch. The work of development is being vigorously pushed, and the prospects of the mine were never more encouraging. The ledge—a wide, well-defined, rich vein—has been struck in the 700-foot levels, and the work of "stoping" out the rock commenced. The main shaft is to be sunk a hundred feet deeper—eight hundred in all—as soon as possible, a contract for the work having already been let. The pay-chimney, which has been mined through the various levels from the surface down, increases in length and improves in quality of ore as greater depth is reached. The 600-foot level is already extended about 300 feet south without reaching the terminus of the pay-shoot. How far the chimney extends to the north has not yet been ascertained. In the bottom of the shaft the ledge shows better than at any point above, and there is every reason for believing that the vein will continue good through the present and many future sinkings.

In this county are many other mines of value in various stages of development, such as the San Bruno, Good Hope, Dolly Varden, Monte Christo, Sheep Ranch, and others, but their condition at the present time is a matter of local rather than general interest. The same may be said of the gravel and hydraulic interests. This class of property is not worked in Calaveras County on the extensive scale described in other portions of this report, since the deposits are not as deep as in other counties, though the average yield per cubic yard is somewhat higher. The Duryea claim, near Mokelumne Hill, affords an example of successful mining in this branch. At Angel's, Carson Hill, and other points on the mother lode, (which runs through this county,) quartz mining has been very dull, being mostly confined to operations near the surface on the small veins, the quartz being run through arrastras. Both the Big mine and the Stickle, noticed in former reports, have been shut down for the greater portion of the year.

AMADOR COUNTY.

This county, which may properly be considered as the second in California in point of its gold-product, is situated on the western slopes of the Sierra Nevada, between the Cosumnes and Mokelumne Rivers, two mountain-streams which form its northern and southern boundaries. The belt of auriferous quartz, known as the mother lode, runs in a general north and south direction through the center of the county, at an average elevation above the sea-lèvel of 1,200 feet. On this belt are situated the mining towns of Jackson, Sutter Creek, Amador City, and Drytown, each the center of a group of noted mines, the most successfully developed of which are the Keystone, Consolidated Amador, and Kennedy, while many others, such as the Oneida, Lincoln, Mahony, Bunker Hill, and Phœnix, will soon rank among the leading quartz-mines of the State. The outcrops of quartz in which these mines are situated are directly on a line with the great quartz-veins of Mariposa, Tuolumne, and Calaveras Counties. This zone, known as the mother lode, seems to have its northern extremity within the limits of Amador County, or at least its continuity is here seriously disturbed. Further north, however, in El Dorado County, the Saint Lawrence mine, near Georgetown, presents many of the characteristics of this great vein. It is, however, remarkable that the deep gorge of the South Fork of the American River, which crosses the supposed line of the mother lode, between Drytown and Georgetown, has not uncovered this vein to such an extent that its identity can be demonstrated.

Professor Whitney, State geologist of California, says of this vein: "It is not by any means a continuous bed or vein of quartz, but rather a series of nearly parallel belts or lenticular masses, with barren intervals between them, but yet arranged nearly in the same course, so that a straight line drawn in a direction of north 27° west from Jackson, Amador County, would either cut or pass through very nearly the whole of them."

Yet this lode can be traced, by a succession of massive croppings and other easily recognized tokens of its presence, along a nearly straight line for a distance of nearly sixty miles. Throughout its entire length, from the Princeton and Josephine mines, on the Mariposa estate, to the Keystone mine, near Drytown, Amador County, there occur at intervals vast, wall-like outcrops of quartz, forming an impressive and picturesque feature of the landscape. The vein, in its upper portion, pitches toward the east at an angle of 45° to 50°, gradually approaching a vertical position as depth is attained.*

In thickness or width it varies from 1 foot to 50 feet of solid quartz, but sometimes expands to a width of 100 feet or more, in which case the vein-matter is partially filled with fragmentary slate and broken quartz. It is everywhere regularly walled, and uniformly carries a well-defined "gouge" or selvage of argillaceous clay, greatly facilitating the extraction of its ores. The western or foot wall is slate or greenstone, and the eastern or foot wall, metamorphic slate, sometimes termed "bastard granite" by the miners.

The vein-matter of the mother lode consists of gray or white quartz, impregnated with about 1 per cent. sulphurets, and rarely producing "specimen-rock" or free-gold-bearing quartz. Generally the gold is disseminated throughout the vein-stone in such minute particles as to be invisible to the naked eye.

The ore does not occur in a continuous channel, but in a series of chimneys or pay-shoots, separated by stretches of low-grade ore, barren quartz, or argillaceous slate. The longitudinal inclination of these chimneys is sometimes northward, and at others southward. In vertical continuity none of these pay-shoots have, up to the present time, been completely cut off; and the experience of sixteen years' exploration on this lode has demonstrated the fact that the pay-shoots may continue to a depth where mining, unless there should be a great improvement in the grade of the ores, will cease to be profitable.

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* In this recapitulation no attempt is made to discuss the nature of the mother lode. A theory on the subject is suggested in my first report, rendered in April, 1868.—R. W. R.

The average yield of ores from the mother lode, or at least that portion within the limits of Amador County, may be stated at $16 per ton, although the Consolidated Amador has for several years yielded an average of $20 per ton. This mine is now opened by levels to the depth of 1,600 feet, and by the main shaft to the depth of 1,700 feet.

One of the most important enterprises now in course of completion in California is that of the Amador Canal and Mining Company. This canal is intended to supply with motive power the hoisting-works and mills of the various mines on the mother lode in this county, in place of steam, which, owing to the increasing scarcity of wood, is becoming too expensive a power to permit the mining and reducing of ores yielding less than $8 per ton. In the prosecution of this enterprise, the ground was found more unfavorable than was anticipated, and the cost far exceeded the first estimates made; but, for sixteen months, the work was prosecuted steadily, until the canal was completed to its junction with the old Butte ditch, a distance of thirty-five miles from the reservoir at Sutter Creek. At this point it was expected that the old Butte ditch would supply sufficient water to meet the demands of the quartz-mining companies with whom contracts had been made; but, owing to the extreme dryness of the new canal and the great evaporation of water, caused by the unusual and continuous heat of the weather, it was found impracticable to take so small an amount of water through such a great length of canal, and the attempt was abandoned, leaving, as the only course open to the company, the finishing of the canal direct to the Mokelumne River, a distance of nine miles from its present terminus.

According to the reports of General Alexander and Sherman Day, this additional work can be executed at a cost of from $45,000 to $50,000, and the expenditure of this amount is alone required to complete an enterprise which will supply a want felt by the whole community, and cause millions of dollars to be taken from the ground, which otherwise must remain forever untouched. It will not affect alone the gold of the quartz-mines, but also thousands of acres of land covering placer and hydraulic claims which have heretofore remained unmined, owing to the impossibility of obtaining water to separate the gold from the soil.

Mr. Sherman Day, civil and mining engineer, in his report to the Amador Canal Company, says:

> By a well-established formula in hydraulics, I estimate that a canal of this area (19¼ square feet, and grade of 8 feet per mile) when running full at 13 feet deep, ought to deliver 5,489 cubic feet per minute. General Alexander estimates the delivery at 5,943 cubic feet per minute. These figures are derived from a reduction of 64,016,640 gallons in twenty-four hours to cubic feet, at the rate of 748 gallons per cubic foot. The two estimates do not differ materially; but probably both ought to be modified by some co-efficient, derived from actual experiments and measurements, made on the flumes and ditches of California. Such measurements are extremely rare, and, when made, have usually been expressed in "miners' inches," an expression as uncertain as the flow of water itself. I am indebted, however, to Mr. Henry T. Knight, superintendent of the Natoma Canal, at Folsom, (which is a little larger in cross-section than the Amador Canal, but has a much less fall per mile,) for a measurement which he made by repeated observations at a long flume, with floats and current-meters. Comparing the actual discharge determined by his measurement, with the theoretical discharge due to the area and grade of his canal, I infer that the actual discharge of this class of canals, (carrying a cross-section of about 20 to 24 square feet) should be estimated at

> eight-tenths of the theoretical discharge. Applying this to my estimate would give a flow of 4,391 cubic feet per minute, and the General Alexander's of 4,754 cubic feet.
>
> A cubic foot is something certain; but as to what a "miners' inch of water" is, doctors differ widely. Calaveras County uses one kind of orifice for discharge; Amador County another, and El Dorado County has two or three kinds. Each gives a different quantity, varying from 1⅝ to 2¼ cubic feet per minute. Without incumbering this report with the minutiæ of hydraulic computations, I consider that 2 cubic feet per minute would be a fair and liberal estimate for the inch of water as used in Amador County. But as a miners' inch, as sold, runs only twelve hours, and the night-flow is saved up to be used on the morrow, we may estimate that one cubic foot per minute, flowing twenty-four hours, will provide one miners' inch for twelve hours. The capacity of your canal will be, therefore, 4,391 inches for twelve hours in each twenty-four.
>
> The whole length of the canal is forty-five miles, and its cross-section is 5 feet wide at the bottom, 8 feet wide at top of water, depth of water 3 feet when full, and descent per mile 8 feet. There are two reservoirs provided for: one of about 4 acres at the lower end, on Tanner's ranch, near the town of Sutter Creek, at a convenient height and distance for distributing the water, through pipes, to the various quartz mines and mills; another of about 130 acres, near the New York ranch, on the Volcano road, capable of holding 84,942,000 cubic feet of water. There are two inverted siphons or large iron pipes, 32 inches diameter, instead of flumes across wide ravines, of the respective lengths of 1,690 feet and 1,584 feet. This canal will distribute water-power and water for amalgamating purposes to eight gold-quartz mines and five quartz mills—to the Kennedy with 40 stamps, the Oneida with 60, the Amador with 40, the Lincoln with 20, and the Mahoney with 20; and to the shafts of all the mines named; and also those of the Summit Mine Railroad, (now a part of the Amador,) and the Maxwell mine. These mines are all on "the great mother ledge" of California, in which the Amador shaft (formerly Hayward's mine) is sunk 1,600 feet, and has yielded more gold than any one gold mine in California. By a contemplated branch canal, to leave the main canal on the ridge, the water can be taken across the divide between Sutter and Amador Creeks and supply power for the 40 stamps of the Keystone mine, and 40 more of the original Amador mine.

General Alexander estimates that one miners' inch of 21,000 gallons, falling 380 feet, (during twenty-four hours,) will furnish one available horse-power, and as the Amador Canal delivers 3,048 miners' inches in twenty-four hours, it will furnish that number of horse-powers where a fall of 380 feet is attainable, and a greater or less number according to fall.

I quote further from Mr. Day's report:

> An average cubic foot of water weighs 62⅝ pounds, and the horse-power of any number of pounds or cubic feet falling through hydraulic pressure-pipes can be easily determined by the tables furnished by the manufacturers of the improved turbine-wheels. The entire fall, from the reservoir down to the Amador Mill, on Sutter Creek, is about 486 feet. Whether turbine-wheels can be constructed to work well in practice, and utilize, without waste, *all* the power of the water at that enormous pressure, I am not sufficiently informed; but I am credibly informed that it can be done at 300 feet, and it may, therefore, be well, in estimating the expenditure of water, to provide sufficient for a pressure of 300 feet. In addition to the stamp-mills already in operation, the owners of some of the mines are desirous of erecting more stamps for the purpose of crushing low-grade ores, which do not justify reduction by expensive steam machinery.
>
> I have already enumerated 260 stamps now in operation, or usually running, all by steam. At the rate of 1½ horse-power per stamp they would rquire 390 horse-power for the mills alone.
>
> About one-third to one-half as much more may be estimated for hoisting and pumping at the shafts—say altogether 600 horse-power to be provided for the existing mills and mines. At 300 feet fall, with a deduction of 25 per cent. for friction and waste of power, 2¼ cubic feet per minute would furnish about one horse-power. At that rate the 600 horse-power would require 1,350 cubic feet of water per minute.

The estimated surplus, after supplying the contracts already made with the quartz mines, will be 60,000 gallons per day for general mining and irrigating purposes.

The total cost of this great work will not be less than $250,000. Its completion will give facilities for working many valuable mines now lying idle, as well as opening up extensive areas of gravel and hydraulic ground. This class of mines will be supplied with water at 10 cents per inch.

Contracts have been made with several quartz mining companies on the following terms per month:

Companies.	For shafts.	For stamps.	Total.
Amador	$450 00	$1,500 00	$1,950 00
Oneida	300 00	750 00	1,050 00
Maxwell	150 00	900 00	1,050 00
Keystone	300 00	600 00	900 00
	1,200 00	3,750 00	4,950 00

On the same basis the following companies would pay for motive power:

Companies.	For shafts.	For stamps.	Total.
Kennedy	$150 00	$300 00	$450 00
Downes	150 00	300 00	450 00
Mahony	150 00	....	150 00
Summit	150 00	....	150 00
	....	....	1,200 00

Making a grand total of $6,900.

A notion of the importance to quartz miners of a substitution of water for steam as a motive-power, may be obtained from a statement of the expense of running one mine with steam machinery. I take, as an example, the Kennedy mine, at present running a 20-stamp mill, and hoisting by machinery from a shaft 400 feet in depth. The monthly expenses incident to steam machinery are as follows:

At hoisting-works:

2 engineers, at $90 per month	$180
50 cords wood consumed per month, at $5.50	275

At mill:

2 engineers, at $80 per month	160
100 cords wood, at $5.50	550
	1,165

Thus it will be observed that there will be a difference of $715 per month in favor of water as a motive-power at this mine. The wear and tear of machinery will be about the same.

Mr. W. T. Henson, of Lower Rancheria, in this county, makes the following estimate of the cost per day of running with water-power a first-class 40-stamp mill, (750 pound stamps,) capable of crushing 80 tons per 24 hours:

Wear and tear of mill per day	$12 00
Four feeders, at $3 per day	12 00
Two Chinamen, rock-breakers, at $1.25	2 50

Two Chinamen to attend concentrators, at $1.25	$2 50
Two Chinamen, extra work, at $1.25	2 50
Oil and lights	1 00
One extra man	2 50
Motive power (water)	15 00
Superintendent	8 00
Loss of mercury (percentage)	2 00
	60 00

Or, $1,800 per month; while it now costs the Kennedy $1,305 per month to run a 20-stamp mill (450 pound stamps) with a crushing capacity of only 20 tons per day. The Kennedy mill crushes 500 tons per month at an expense of $1,305, while a mill of 40 stamps, with water-power, would crush during the same period 2,000 tons at an expense of from $1,800 to $2,000.

The leading mines on the mother lode have been described in former reports. The principal one is the Consolidated Amador, formerly known as Hayward's Eureka. The report of Mr. Steinberger, the superintendent, gives an account of operations from December 1, 1872, to February 1, 1874, from which the following particulars are extracted:

> There has been taken from the mine and crushed at the Eureka (40-stamp) Mill 22,465 tons quartz, the average yield of which was $17.91. A large amount of dead-work, such as driving drifts, sinking shaft, repairs on shaft, &c., has been done. The retimbering of north shaft, from San Francisco to "Green" levels, a distance of 200 feet, caused a partial stoppage of the working of the mine for over two months, the expense of which was a little over $6,000. The only surface improvement of any note was the purchase of a new boiler, the cost of which, including the setting, material, &c., was in round figures, $6,000. The aggregate length of drift driven within the year was 1,637 feet. The north shaft has been sunk 260 feet, making it now in depth 1,685 feet. The vein was very large in the shaft from the "Colton" level to within about 25 feet of the bottom, where it gradually narrowed down to 4 feet in thickness, and shows that thickness now in the bottom. The quality of the rock has been much better in the last 20 feet of sinking than it was above in the shaft, when the vein was so large. From the "Colton" level down the vein shows much confusion, and the general character of the vein differs in look and quality of rock from that in the levels above. The "Colton" level has not turned out so well as was anticipated. The south drift has been driven 147 feet from north shaft. In starting this drift the vein looked most promising, and the rock was very rich. Unfortunately it lasted but a few feet, and the rock became poor the entire width of the vein, and so continued for from 60 to 70 feet south of shaft, when the face of the vein next to the gouge or foot-wall improved in quality, about 4 feet of the vein being good rock; it has so continued to the present face of drift, that portion of the vein on the hanging wall south being poor. The entire vein was taken out for 60 feet south of the shaft, at which point the hanging wall ran off very fast to the east, increasing the size of the vein; for the 60 feet the vein averaged 8 feet. The vein became so large that it was deemed best to take about 7 feet of vein down on the foot-wall side, leaving the balance of the vein, the thickness of which has not as yet been tested.
>
> The vein north of the shaft on this level was very much confused and broken for a distance of some 70 feet, the vein being badly mixed with slate and carrying but little gold. At that point the vein became concentrated, and was in thickness about one foot. It has been gradually increasing in size, as well as in quality, up to the face of the drift, which is 120 feet from the shaft. The vein is now in thickness 55 feet, and in quality very fair rock. The quality of the rock has improved very much on this level, both north and south, in the past few weeks, as the mill-results show. The Boulder vein in "Green" and "Latham" levels is low-grade rock. No stoping has been done on these levels on the Boulder vein. The drifts show a vein in thickness from 18 to 20 feet. So soon as the new ditch is completed, which is expected by the 1st of July next, this rock can be worked with profit by water-power. The eight-hundred-foot level has developed a very large body of bowlder-rock, the vein being from 15 to 20 feet in thickness. A mill-test from this level shows that it pays from $10 to $12 per ton. It is believed that there is ore in the bottom of the mine east of the present workings, since the bottom of the shaft shows a slate hanging wall, which is not natural to the vein. The true granite wall is supposed to be farther east. This is to be tested by a cross cut.

The ore-statement for fourteen months is given by the secretary as follows:

	Ore crushed.	Bullion.	Average per ton.	*Premiums.
	Tons.			
December, 1872	1,503	$52,891 76	$35 19.08	$215 79
January, 1873	1,765	44,107 89	24 99	196 85
February, 1873	1,850	45,110 79	24 38.421	180 57
March, 1873*	1,650	25,859 55	15 67.245	159 08
April, 1873	1,329	18,331 81	13 79.3	95 39
May, 1873	975	11,286 96	11 57.565	65 45
June, 1873	1,302	15,524 29	11 92.341	88 48
July, 1873	1,382	25,111 84	18 17.06	131 46
August, 1873	1,520	28,120 24	18 50	146 80
September, 1873	1,830	34,663 60	18 94.13	166 28
October, 1873	2,001	44,174 81	22 07.7	203 73
November, 1873	2,053	25,637 74	12 48.794	145 91
December, 1873	1,600	10,637 75	6 64.850	57 43
January, 1874	1,700	20,836 37	12 25.660	100 00
Totals	22,460	402,294 70	17 91.16	1,953 26

* The value of the bullion is usually reckoned on the books, before the actual receipt of coin for it, about 1½ per cent. too low. The surplus received for the bullion is charged to premium-account.

The statements of receipts and disbursements show the following items:

Receipts:

Cash from former companies	$64,943 45
Bullion and premium accounts	404,247 96
Rents and sales	2,192 26
Total	471,383 67

Disbursements:

Labor, drifting, and stoping	$68,464 08
Sinking	16,780 74
Surface and sundry	20,944 64
Supplies	62,820 93
Construction and improvement	27,571 05
Mill-labor	21,255 45
Mill-supplies	25,895 52
Freighting and teaming	5,683 67
State and county tax	13,258 64
Salaries, insurance, &c	24,544 39
Dividends paid	180,000 00
Cash on hand	4,164 56
Total	471,383 67

The assets of the company, exclusive of the mine itself, are valued at $142,000 in buildings and machinery, and $37,752.19 in supplies, furniture, animals, &c., one hundred tons of sulphurets on hand being reckoned as worth $10,000.

Among the promising of the newer mines is the Kennedy, situated one mile north of the town of Jackson, and owning 2,000 linear feet of ground, with mill-sites, water-rights, a 20-stamp mill, and effective steam-hoisting works. The quartz-croppings are bold and prominent, running along the back-bone of the hill on a general course of north 20° west. The formation is slate on the west, with metamorphosed slate on the east, and the ledge dips east at an angle of 45°, with a tendency to pitch at a steeper angle as depth is attained. The Kennedy is opened by two shafts, each provided with powerful hoisting-works, ample for sinking 1,000 feet. Several chimneys have been discovered within the limits of the company's ground, and two of these have been extensively developed. These are respectively termed the Kennedy and the Pioneer chimneys. The Kennedy chimney has been developed to a depth of 400 feet, and found to be 150 feet in length, showing at the lowest level an undisturbed ledge. Its width varied from 2 feet to 12 feet. The Pioneer chimney is situated farther south, near the junction of the Pioneer ground, and was opened from a level driven southward from the new or lower shaft. This remarkable ore-body has expanded from a mere seam to a width of 18 feet at the Pioneer line. Its length in the Kennedy ground proper is 170 feet, and it is doubtful whether the full limit has yet been reached. Even should this be the case, and the ledge should contract in the ratio in which it has widened, it will prove to be one of the most extensive ore-bodies opened on the Mother lode. The south workings from the old shaft have not been driven far enough to open this ore-body, and it may, therefore, be looked upon as "virgin ground." The chimneys are separated by contractions of the vein, generally filled with a dark-colored talcose matter, termed "gouge." The foot-wall maintains a uniform dip throughout the whole extent of the ground opened. The Kennedy Company run a 20-stamp mill of 20 tons capacity per day, which is kept running with regularity by the employment of six miners. In consequence of the width of the ledge this small force has been enabled to keep the mill running almost without interruption during the past two years, from November, 1871, to November, 1873, inclusive. During that period the product of bullion has been $183,427.40. Calculated on an average run of twenty-five days per month, (omitting Sundays and holidays,) and eleven months for the year, (allowing for periods of repair,) or two hundred and seventy-five working-days per annum, at 20 tons per day, the total yield for the two years has been 5,500 tons, yielding an average of $16.67 per ton. This confirms the owners' statements, that their rock has yielded from $10 to $20 per ton, according to the portion of the mine worked, the Kennedy chimney having yielded a higher grade of ore than the Pioneer. The labor in this mine is a small item of the expenses, owing to the width of the ledge. At the period of Mr. Skidmore's visit six miners were employed, of whom four were running drifts and two stoping. This small force kept the company's mill supplied, running 20 tons per twenty-four hours.

The following statement of the monthly expenses of the Kennedy mine may prove of interest as an example of the cost of working a mining property in this portion of Amador County:

Mine expenses.

Superintendent, per month, (for mine and mill)	$400
Foreman, per month	200
3 miners, at $77 each	231
3 miners, at $67 each	201
2 engineers, at $90 each	180
2 landers, at $67 each	134
1 outside man	67
1 blacksmith	100
1 carpenter	100
50 cords wood at hoisting-works, at $5.50	275
Total	1,888

To this may be added wear and tear of machinery, gunpowder, candles, steel, &c., of which no record has been kept, but which may be placed in a general estimate at $112 per month, thus making an expense of $2,000 per month, or about $4 per ton for mining. This, of course, includes all "dead work" incidental to keeping the mine opened in advance.

Mill expenses.

Amalgamator, $100 per month	$100
2 engineers, at $80 per month	160
3 feeders, at $50 each and board, say	200
1 sulphuret-cleaner	80
Wear and tear of mill	100
100 cords of wood, at $5.50	550
Loss mercury, per month, (estimated)	20
Oil and lights, (estimated,) per month	20
	1,230

Perhaps no better example could be given of the relative expense of crushing by heavy and light stamps, and of the relative expense of steam and water as a motive-power, than that afforded by a comparison of the estimate of Mr. Henson with the actual cost of running the Kennedy mill.

The expense of mining is therefore $4 per ton, and of milling $2.46 per ton, which has afforded a net profit of about $10 per ton for two years past. The expense of mining would of course be materially reduced if 40 instead of 20 tons per day were produced, as it would not require any additional expense above ground, at the hoisting-works, but only a slight addition to the mining force.

Mr. W. F. Aram, one of the editors of the Sutter Creek Independent, has recently visited the leading mines of this county, and furnishes the following description of the present condition of two of them. With respect to the Amador consolidated, he says:

> At what is known as the 800-foot level—being, however, only about 700 feet from the surface, some error having been made in its first measurement—rock is being taken from the bowlder-ledge. The true ledge lies east of this and was partly worked on the north side of the shaft when the mine was under Hayward's management, but has not been worked to the south of the shaft. The bowlder-ledge is about 30 feet in width, the rock averaging about $10 per ton. The width of the main or true ledge is probably about 10 feet, and the rock of better quality than that of the bowlder. It is the intention to work around to the main ledge on the south side of the shaft, and then work southerly to the Badger shaft, about 75 feet distant. In the Latham level, 1,350 feet from the surface, a drift has been run northerly 450 feet. The last 80 feet of this drift is in the bowlder-ledge, which will here average at least 30 feet in width, and in value from $8 to $12 per ton. In the Latham level its width has not been determined, no hanging wall having been reached as yet at the end of the drift, nor is it known how much farther it extends northerly. In the Panama level, 200 feet above the Latham, the ledge is shown for a distance of 545 feet, and will average for that distance at least 12 feet in width, being in some places 40 feet wide. In the San Francisco level, 110 feet above the Panama, a drift has been run 180 feet, in the whole of which the ledge will average about the same as in the Panama. No rock of any consequence has been taken from any of these levels except that necessarily extracted in running. and it therefore remains almost untouched from the 1,350 to the so-called 800-foot level. This bowlder ledge dips northerly. It is an enormous body of ore, and though of comparatively low grade, can be profitably worked. The principal work upon the main vein is being done in the Colton level, which is 1,555 feet below the surface. At this point there is a magnificent ledge, and much of the rock is exceedingly rich. This level has been run southerly from the shaft 125 feet. For a distance of 80 feet from the shaft the average width of the vein was 6 feet; at that point, however, it widened rapidly, and although the drift is being run 15 feet wide from the foot-wall, there is

still a solid body of ore left upon the hanging wall, and the width of the ledge for the last 40 feet and beyond is unknown. To the north of the shaft a drift has been run 100 feet, the ledge being 3 feet in width. The rock in this level averages from $20 to $30 per ton. On the north side no stoping of any consequence has yet been done, and on the south side the stopes have only been run up about 20 feet. The main shaft has been sunk 90 feet below the Colton level, rendering the total depth of the mine 1,645 feet. At this point a new level is to be made. The rock in the bottom of the shaft is good. The water is raised from the bottom of the shaft by means of two steam-pumps to the Panama level, from which point it is hoisted in buckets through the Badger shaft. An average quantity of 80 barrels or 20,800 gallons is hoisted daily. The ventilation throughout the mine is excellent. The average number of men employed under ground is 74.

In the Mahoney mine, considerable drifting has been done at the 500-foot level, but no work is now going on there. The water, of which there is a considerable quantity in this level, is collected in reservoirs, from which it is forced to the surface by means of a steam-pump. At the 600-foot level, 620 feet below the surface, a drift has been run north along the ledge 170 feet, for the purpose of prospecting. This drift runs the entire distance through vein-matter, and was run close to the hanging wall, but at short intervals cross-cuts were run westerly to the foot-wall, showing the width of the ledge to be about 50 feet. The ledge-matter is a white quartz containing some sulphurets, and occasionally rich spots are found containing free gold; but the rock as a whole is not rich enough to pay for working. It resembles very much the "bowlder ledge" of the Amador mine, though not of so rich a quality. In this drift a wedge-shaped body of rich rock was found of considerable extent. This body has been worked out upward, but none of it has been taken out below the drift, though there is undoubtedly a quantity of the same character of rock still there. At various points in this drift where cross-cuts have been run, a vein or seam of black gouge is found extending through the ledge-matter a short distance from the hanging wall, parallel with the ledge, and dividing it into two portions. This is considered favorable, as an indication that the true ledge is becoming divided from the bowlder. The water in this level is collected in a reservoir capable of holding all that collects in twenty-four hours. From this reservoir it is hoisted to the surface in the bucket. The shaft is down 30 feet below the 600-foot level, or 650 feet below the surface, and is being sunk as rapidly as possible. The rock in the bottom is similar to that above, not sufficiently rich to work but containing occasional rich spots. All the work about the mine has been done in an excellent manner, and reflects much credit upon the superintendent and his foreman, Mr. Joseph Bath. It is intended to sink the shaft at least 300 feet farther.

A correspondent of the Amador Ledger gives the following account of a rich portion of the county which has been somewhat overlooked:

Between Butte City and the Mokelumne River, in Joe's Gulch, a newly-discovered quartz-ledge is being opened by Adam Smith & Co., which promises to become one of the best-paying mines in the county. The shaft is at a depth of 25 feet; the lode is 4 feet in width, and 6 inches of the ledge, just adjoining both the foot and the hanging walls, shows free gold in considerable quantities, and it is estimated that much of the rock taken out will pay at least $60 to the ton. * * *

In a direct range, and not far from where the prospecting of this ledge is being done, is located what is known as the Wiley Mine. With the exception of a few months' prospecting, it has remained unworked for the past fourteen years. As far as worked, it has proved to be what is usually termed a "pocket-mine," though nearly all the rock taken from the lode paid extraordinarily well for crushing. At the time it was being mined, between the years 1855 and 1858, the lead yielded enormously, paying from the very surface, with increasing plentifulness, till 50 feet in depth was reached. The "chimney" of the ledge is about 100 feet in length, and has been pretty thoroughly worked to the lower level, and the most of the gold came from pockets in the decomposed quartz. It was not unusual to find from $100 to $500 to the pan. One nugget of $700 in value was found on the very surface. The want of sufficient capital has long prevented the further development of this extraordinary mine; but work on it will be resumed the coming spring.

A few years ago a pocket was found a short distance below the Wiley lead, on the northern slope of the hill, from which $1,000 was panned out in two days by a couple of boys, who had discovered the gold where it cropped out of the surface of the bed-rock in a race where water had been run in mining off the surface-earth. This rich mass of decomposed quartz had every indication of being a slide from the main Wiley lead.

On Murphy's Ridge we find, for nearly a mile in length by three-fourths of a mile in width, one uniform mass of gold-bearing quartz-veins, interwoven in slate and granite, and all dipping toward the center of the ridge, thus unmistakably indicating a concentration in the direction of the Mother lode, which is rationally supposed to be not very remotely sunk beneath the surface of its almost numberless tributaries, of which so many have heretofore afforded a treasure to fortune-seekers, while those which are now being worked still continue their remunerative yields. The principal composition of the shallow earth capping the ridge seems to be decomposed quartz, and all contains more or less gold. The best pay thus far has usually been found in pockets, commencing immediately underneath the surface-dirt and extending to various distances of not very great depth. Several years ago a company of three Germans took out in a pan, in less than half a day, $5,000, all the gold being nearly free from undecayed quartz.

The section of the ridge at present bearing the most favorable indications is in the immediate locality known as the Sylvester claim, which has been almost continuously worked for the last fifteen years, and, considering the limited manner in which the labor on the mine has been prosecuted, it has paid astonishingly well. The slate, with which the quartz is profusely intermingled, is much broken and decayed, and has gold entirely through it. The style of working the claim has been, and at present is, to dig and pulverize the slate and rotten quartz during the dry portion of the year, panning or rocking the pockets found in the mean time, and then wash the remaining part during the winter season. Much of the decomposed quartz and slate is thickly studded with sulphurets, which are richly and visibly impregnated with gold. For a mile distant from the lower end of the ridge, toward the Mokelumne River, the same singular formation continues, and, though not as thoroughly worked as Murphy's Ridge has been, many rich deposits on the range have been found, among them the noted Spanish mine, located near the head of Spanish Gulch. Like the ridge of which I have been speaking, this whole section remains undeveloped, solely for the want of necessary prospecting means.

The prospects of Amador County were never so flattering as now. The advances which are being made in the various industries are founded upon the great natural resources of the county, and are of such a nature that they will be permanent and lasting. The mines are paying better than ever, and the work of the past few years in gold and silver mines here and elsewhere has shown conclusively that the greater the depth the richer and more permanent the ledge. At a depth of 1,700 feet the Amador mine has an excellent ledge of rich rock, and in the lowest levels of the Lincoln and North Amador mines the prospects are quite as favorable. The developments of the Lincoln mine, made during the past few months, render the present milling facilities of that company entirely inadequate, and a new 40 or 60 stamp mill will be erected next year. The 20-stamp mill with which their crushing is now done is of old-fashioned construction, and of comparatively small capacity. But even with these facilities, such is the richness of their rock, that their monthly proceeds reach a remarkably high figure.

The coal-beds are also supposed to be very extensive, and considerable prospecting is now being done, with every prospect of success. One mine, near Ione City, has furnished the quartz-mills of Sutter Creek, Amador City, and Oneida Valley nearly six thousand tons, at a cost to the mill-owners of about $24,000, or $4 per ton.

There are two copper-mines in the county, which are paying and permanent. The Cosumnes mine, situated near Michigan Bar, keeps forty men employed, and reduces the ore at the mine by smelting, making it yield about forty per cent.

The Newton Mine, situated three miles east of Ione City, on the Jackson Road, is in a very flourishing condition. The company has taken down all the old machinery and put up new. The ore is worked by the leaching process, and reduced to 90 per cent. This mine keeps twenty-five men employed.

Near Lower Rancheria two mines of promise have been opened during the year—the Gold Mountain and White Mountain. Both of these mines show vast croppings of quartz of fair quality, said to be so situated as to admit of extraction and milling for less than $2.50 per ton. A 40-stamp mill will be erected on the Gold Mountain early in 1874.

The returns of the county assessor show fifteen quartz-mills, which have crushed 81,000 tons of rock. This, if correct, shows a great falling off in the business of quartz-mining. The county contains hundreds of undeveloped quartz-mines, which will be prospected on the completion of the Amador canal.

Between Jackson and Drytown, we find a line of quartz-mines on the Mother lode opened at depths varying from 300 to 1,600 feet. A local agent was employed to obtain returns from this group of mines, but he was not successful, owing to the reluctance of owners to furnish information. Such returns as have been been filled show the general condition of mining on the Mother lode, and are given below.

The London and California Company, owning the Erie, Pennsylvania, and Original Amador, has stopped operations on the first two mines, having spent during the last six months of 1873, upon the Erie, £4,863, to produce £884; on the Pennsylvania, £3,429, to produce £1,380; and on the Amador £4,115, to produce £1,659. In December, the Amador shaft was down 260 feet, and work will for the present be confined to deepening and exploring this mine. The proceedings at the annual meeting, just held in London, indicate much keen disappointment among the stockholders, who had been led by reports, based on the mill-returns of former proprietors, to expect some £76,800 profits annually. It is probable that the mill-returns were genuine, but that the mill had been run on selected rock, far richer than the apparent reserves of the mines. A trick of this kind is hard to detect, in a case in which even the rich rock is of too low grade for ordinary assays.

Statement showing operations of leading mines of Amador district, Amador County, California, for year 1873, reported by W. A. Skidmore.

Mines.	Owners.	Total No. tons raised.	Total No. tons worked.	Average yield per ton.	Total bullion product.	No. stamps employed.	Cost mining, per ton.	Cost milling, per ton.	Company or custom mill.	Miner's wages per day.	No. miners employed.
Consolidated Amador	Incorporated Company	19,000	18,000	$20	363,898	10 to 40	$4	$1 75	Company	$3	60
Kennedy	Reichling & Company	5,000	5,000	16		20		2 40	....do	3	6

REMARKS.—No returns were received from the Mahoney, Oneida, Keystone, and other prominent mines of the district.

List of producing mines in Amador district, Amador County, California, reported by W. A. Skidmore.

Name.	Owner.	Location.	Course.	Dip.	Dimensions.		Development.		Country rock.	Vein-matter.	Average value, per ton.	Per ct. sulphurets, per ton.	Number tons extracted and milled during year.
					Length.	Thickness.	Depth main shaft.	Total length drifts.					
						Feet.	*Feet.*	*Feet.*					
Consolidated Amador	Incorporation	Sutter Creek	N. & S.	71° E.	3,000	2 to 30	1,630	4,000	Slate on west and metamorphic slate on east.	Quartz	$20	½	19,000
Lincoln Gold-Mining Co.	....do	....do	N. & S.	63° E.	1,900	1 to 40	500	1,300	......do	....do	15	1	No returns.
Kennedy	Reichling & Co.	Near Jackson.	N. & S.	46° E.	3,000	2 to 25	400	280	Slates	....do	16	1	5,000 to 6,000.

REMARKS.—The Lincoln Mining Company will erect a 60-stamp mill early in 1874. The Kennedy will soon erect a first-class mill. No returns could be obtained from the Mahoney, Oneida, and Keystone.

List of mills in Amador County, California, reported by W. A. Skidmore.

Name of mill and owners.	Location.	Power—steam or water.	Horse-power, engine.	No. of stamps.	Weight of stamps.	No. drops per minute.	Height of drop.	No. and kind of pans.	No. and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours.	Crushing capacity of mill per 24 hours.	Loss of mercury per ton.	Cost of treatment per ton.	Running time.
					Lbs.		*Inches.*				*C'ds.*	*Tons.*	*Per ct.*		
Consolidated Amador	Sutter Creek	Steam and water.	75	40	700	75 to 80	9	2 Hepburn	Sluice and buddle	$40,000	6½	60	20	$1 75	Has not run with regularity during year.
Lincoln Gold-Mining Company.	do	do	25	20	600	80	8	None	Concentrate by buddle and sluice.	20,000	3½	30		1 25	12 months.
Kennedy	Near Jackson.	Steam	46	20	450	80	9	do	Sluice.	20,000	3½	20	Slight.	2 40	10 months.
Keystone	Sutter Creek	do	125	40	750	85	6½					60			

REMARKS.—No returns were received from the Oneida and other mines and mills in vicinity of Sutter Creek.

EL DORADO COUNTY.

The gravel ranges of this county were fully described in a former report by Mr. W. A. Goodyear, of the State geological survey, and also by M. D. Fairchild, of Georgetown, and E. N. Strout, of Placerville. Since the publication of the descriptive matter furnished by those gentlemen, there has been but little change in the status of hydraulic and gravel-mining of the county. The owners of mining-ground are awaiting the completion of the three great ditches now in course of construction, for the purpose of furnishing to the mining-region of the central portion of the county an abundant supply of water. These projects are known as the El Dorado Water and Deep Gravel Company, the Mount Gregory Water and Mining Company, and the California Water Company.

The El Dorado Water and Mining Company was organized for the purpose of supplying water to the mining-region in the vicinity of Placerville, where there are many thousand acres of auriferous gravel-beds and channels of known richness. The first steps taken by the company were to acquire, by purchase, all the property-rights of the old South Fork Canal Company, with some extensive and valuable mining-ground connected therewith, and also of the Gold Hill, Iowa, and Weber ditch companies, aggregating some one hundred and forty-four miles of ditches and flumes, the construction of which formerly cost from $800,000 to $1,000,000. The three latter, however, only afforded water for a few months in the year, and even the South Fork, although it took its water from a perennial source, had a capacity of only 1,000 miner's inches, and was too low to reach many rich localities. Embraced in these water-rights are some eighteen or twenty lakes at the summit of the Sierras, which feed the various tributaries of the South Fork of the American River, from which this company propose to take their water, at an elevation of about 4,000 feet. These lakes and tributaries have a water-shed of about two hundred and eighty square miles, and as the former are some ten miles square in area, they constitute a perennial source of an abundant supply. Their storage capacity, however, can be greatly increased by the construction of dams, upon which considerable work has already been done. The company proposes to make a considerable number of artificial reservoirs, to catch the water at points where the conformation of the country is favorable for such purposes. It will commence in the early spring the construction of one of the largest canals for mining purposes ever made in the State. The extensive area to be supplied by this company was in early times among the most productive of the placer regions of the State.

The California Water Company and the Mount Gregory Water and Mining Company are proceeding vigorously with their ditches, and the benefits of their operations are already felt in an increased bullion product of the portion of the country supplied by them. Both of these works, the details of which were given in the report of last year, will be completed during the year 1874.

This county presents many singular and remarkable phases in the mode of occurrence of the precious metal, as instanced by the so-called "auriferous porphyries" of Placerville, the foliated and plated gold of the Cederberg, the granular gold of the Sliger, the crystallized specimens of Spanish Dry Diggings, and the seam-diggings of Greenwood and Georgetown. Within the year a still more remarkable and exceptional development has occurred in the vicinity of Placerville, and is described by a writer in the Democrat, substantially as follows: (I have omitted a few extravagant adjectives.)

> The Stuckshlager claim has been yielding after the manner of "the good old days of '49." In one spot 40 ounces were obtained from a single pan of the deposit, gathered up without selection from its native bed. Another panful scraped from the slanting bed-rock yielded over $100. The gold is of extra fine quality, has a rusty—sometimes quite black—appearance, and is found in a seam or small ledge of conglomerate material. This pay-streak crosses the point of a spur that makes out into Granite Creek from the main ridge. The rich seam varies from one and two inches up to a foot in thickness, running nearly parallel with the creek—and toward the main ridge in a westerly direction. The components of the pay-streak are rotten quartz, ferruginous talc, a black substance resembling plumbago, and other substances, all of which, however, are equally charged with gold, bright, rusty or black, from the fineness of flour to the scraggy piece worth a dollar or more. On the clay incline which serves for foot-wall to this novel pay-streak, and which has a slope of twenty-two to thirty degrees, on a stripped surface of 18 by 40 feet there was hardly a space of 6 inches square upon which a liberal showing of gold was not visible, and in places there was almost as much of the precious metal as of baser substances. Here it was in quartz that clung like a coating of plaster to the bed-rock; in another place it flecked the soft material that we would dig out of the soft bed-rock. The discovery of this deposit, like many other of the best mining discoveries in California, was partly accidental. Stuckshlager and others had worked in the bed and banks of Granite Creek, generally making good pay, until they reached a small ravine that makes down from the upper side of the spur above described. Above that in the creek there was little if any gold. But little by little Stuckshlager crept up the steep point, finding a patch of pay-dirt here and another there, until the brow of the spur was reached and the wealth-bearing seam, the source of all his previous small findings, was struck. His process is to pick down and wash off in a ground-sluice the overhanging slate, thus laying bare the shallow but rich pay-streak, sluicing down both sides of the point and obtaining rich pay in both directions. Discoveries that are believed to be extensions of this deposit, having every appearance of being rich, have been made in the main ridge to the north and across the ravine to the south, in both cases several hundred feet—that to the north being from a quarter to a half mile—from the scene of Stuckshlager's operations.

The "seam diggings" of Georgetown and Greenwood are thus described in the same paper:

> The most extensive and successful operations in this line have been in the Nagler and Peterson claim at Greenwood, the Whitesides claim and the Blasdel (formerly the Hart) claim near Georgetown. The Nagler claim has paid enormously, but we have no exact information of the gross yield or net profits. The Whitesides claim is credited with a gross yield of $30,000 last year, of which it is presumed that $22,000 to $25,000 was profit. The Blasdel claim has not been as thoroughly opened nor worked as long as either of the above named. No two of these seam mines are alike, except in general characteristics, but a description of one will give some idea of the others. In all there are seams of decomposed or rotten quartz, imbedded in slate of similar consistency. In the Blasdel claim there are several seams—perhaps a dozen or more—which, with the soft slate in which they are imbedded, fill, at the surface, a space of 60 or 75 feet from east to west, narrowing and coming together as they descend, inclosed by walls of slate. The course of the quartz seams and their slate casings is northeast and southwest. The position of the quartz seams and soft slate ledges varies from an almost vertical to an angle of twelve or fifteen degrees. The novelty of the mining consists in the fact that gold-bearing quartz and slate casings are of such consistency that they can be readily quarried, pulverized, and separated from their precious contents by hydraulic power and process. With a good "face" on a ledge, sectionally presented, more ground can be moved with the same amount of water and pressure than in the average of gravel hydraulic claims. It is but seldom, and then generally owing to the position of the strata, that powder has to be used to loosen a bank. In the Blasdel claim an opening 250 feet long and 60 feet deep, and from 15 to 75 feet wide, has been made in a little over one season's washing. They own a ditch which is about four miles long, with some other smaller ditches that catch waste water, and from these they lead the water through 1,700 feet of 9-inch iron pipe to their claim. At a depth of about 70 feet all but two of the quartz seams in this claim have come together, and in a shaft sunk about 30 feet below the bottom of their cut they have decomposed quartz nearly 10 feet in thickness, of the consistency of a tolerably compact sand-bank, and this has yielded on assaying tests at the rate of $18.75 and $19.25 per ton.

The returns of the county assessor show forty quartz-mills, of which, however, but few have run during the year. Most of them are the monuments of the folly of incorporated companies which, during the quartz excitement of 1862, erected mills before the mines were opened. Nevertheless, the county is intersected with numerous quartz-veins of promising appearance. There are several quartz-mines working on a large scale, from which it has not been practicable to obtain returns. The most important mines are the Saint Lawrence and the Cederberg, of which the returns are given below.

Statement of the Saint Lawrence Mine and Mill, Kelsey District, Eldorado County, for the year 1873. *Reported by Charles R. Edwards.*

Owners, Saint Lawrence Gold Mining Company, limited, San Francisco and London; vein, course northwest and southeast; dip, 45° east; length of claim, 1,800 feet; average thickness, 3½ feet; depth of main shaft, 500 feet; total length of drift, 800 feet; country-rock, slate, vein-matter, gold-bearing quartz, with half of one per cent. sulphurets; number of tons raised and milled, 8,062; bullion product, $141,002.13; average per ton, $17.49; steam-mill, 75 horse-power; 20 stamps; weight, 750 pounds; drop, 6 to 8 inches, 75 times per minute; one Wheeler pan and settler; 4 Handy concentrators; cost of mill, $35,000; daily consumption of wood, 5 cords; crushing capacity, 25 tons per twenty-four hours; loss of mercury ⅛ ounce per ton; stamps employed, 20 for eleven months, 30 for one month; running cost, $5 per ton; milling cost, $2 per ton; miner's wages, $3 per day; average number of miners employed, 40.

Statement of the Cederberg Mine and Mill, Greenwood District, Eldorado County, for the year 1873. *Reported by D. M. Boker.*

Owners, Cederberg Gold Mining Company; course of vein, northeast and southwest; dip, 70° west; main shaft, 220 feet deep; drift, 120 feet in total length; country-rock, metamorphic slate, vein-matter, quartz; value, $10 to $100 per ton. This mine is noted for rare and beautiful cabinet specimens, showing foliated and plated free gold. Stamp-mill; water-power; 10 stamps; weight, 600 pounds; drop, 18 inches; no pans; no concentrators; capacity, 12 tons in twenty-four hours; cost of mill, $6,000; running time, 10 months; quantity of ore mined and milled, 1,150 tons; yield, $74,000; average per ton, $65; cost of milling per ton, $2.20; miner's wages, $3 per day; number of miners, 29. The above yield does not include specimen rock not milled.

PLACER COUNTY.

The principal quartz mining districts of this county are Auburn and Ophir, situated in the rolling foot-hill country on the eastern rim of the Sacramento Valley, about 700 feet above sea-level. In this vicinity, the predominating formations are granite and metamorphic slates. The dip of this formation is nearly vertical and the strike north 20 west, to north 45 west. The veins have the same strike, and in most instances are nearly vertical. The slates extend to about three miles southwest of the town of Auburn, where a belt of granite comes in and continues down to the level of the Sacramento Valley.

The metalliferous belt varies in width from three to five miles, and consists of metamorphic slate, trap, and granite. The ore-bearing veins vary in thickness, when in slate, from 18 inches to 4 feet, and in granite from [illegible] to 2 feet. The ores contain gold and silver, associated with pyrites of iron, and occasionally copper, blende, antimony, and arsenic. Pockets and nests of gold are occasionally found, containing gold to the value of from $100 to $100,000; but the general average of the better class of ore, exclusive of these pockets, rarely exceeds $100 per ton, while a large proportion yields from $12 to $16 per ton of 2,000 pounds.

The country within the limits of the auriferous belt above described is intersected by numerous veins of gold-bearing quartz, among which are found some of the prominent mines in the State—among others the Green Mine, the Mina Rica, and the Saint Patrick—the latter being situated in the granite belt near the point of contact with the slates. The decomposition of these, and similar veins, enriched the ravines and gulches of the neighborhood, and formed the rich placers of Auburn and Ophir ravines. It was not until these shallow placers were exhausted that attention was attracted to the quartz veins as the source of the placer gold.

The principal characteristic of the quartz veins of Auburn and Ophir districts is the extraordinary richness of the pay chutes or chimneys, and, so far as developed, their uniform continuity in depth. The veins are rarely of great width—varying from 18 inches to 2½ feet—and, with the exception of the "chimneys," carry what is considered in this district a low grade of ore—from $12 to $18 per ton. This, however, admits of a fair profit on mining and milling. The occurrence of such chimneys is rather the rule than the exception in this district, and the yield from this source may be considered as the most remarkable in the history of quartz mining in California.

The Saint Patrick Mining Company, of San Francisco, has acquired by purchase, location, and consolidation, an extensive and valuable property in Ophir district, and is now taking rank among the leading productive quartz mines of the State. During the fiscal year ending October 30, 1873, a year devoted mainly to exploration and "dead-work," the company extracted and milled from its own ground 3,149 tons of ore, and worked at custom rates for other parties 991 tons, making a total of 4,140 tons, which yielded an aggregate of $69,595, or an average of $16.81 per ton on the whole amount crushed. This is considerably lower than the standard yield of the Saint Patrick ground proper. The average was reduced by the working, on custom account, of several batches of ore which did not pay the expense of milling.

Mr. J. H. Crossman, superintendent, reports to the company the following statement of work performed during his administration, a period of fifteen months: Workings of main shaft sunk, 835 feet; drifts driven, 1,315 feet; air-shafts, 75 feet; cross-cuts, 67 feet; wings, 15 feet.

Mr. Crossman, in his report of the operations of the year, says:

> After a careful examination I came to the conclusion that the main shaft of the Saint Patrick ledge proper had passed through the pay chute on the 200-foot level, therefore considered it useless to sink deeper, unless for another chute. I then commenced explorations to ascertain the dip and width of the known pay chute. During explorations extracted 108 tons of ore from the chute proper, which milled $48.66 per ton, total $5,255.16, and ascertained that the chute was about 60 feet long, dipping in the vein at an angle of 13° easterly. After a thorough test, I came to the conclusion that it could not be profitably worked through the existing shaft, as it would require a level 800 feet long on the 300-foot level, with levels rapidly increasing in length as depth was attained, to reach the chute, while a new shaft 800 feet east from the existing shaft, at a cost of $14,000, would cut the chute at a depth of 350 feet, opening the mine for years of future workings. Therefore I decided to discontinue work for a time.
>
> Having exhausted the Saint Patrick ground I bonded the Spanish, on which I drove 510 feet of drifts and sank 352 feet of shaft; extracted 874 tons of ore, which paid per ton $8.37, and advised the purchase, as the vein was large and the ore yielded a small profit. When an adit level shall have been driven from a point opposite the mill into the hill, on the vein, the ore can be trammed directly to the mill floor without re-handling. The work has been recently resumed, to test this ground thoroughly before an adit is started.

The Crater ground was afterward purchased by the Saint Patrick Company, and promises to prove a valuable acquisition. Working tests prove the ore to be highly remunerative; and development on the lower levels indicate the existence of one of the most extensive chimneys yet discovered in this district. Mr. Crossmau says of it:

> In the Hanging Wall ledge the pay chute of the vein is undoubtedly Λ-shaped, increasing in length as we attain depth. On the surface the chute is said to have been 40 feet long; on the 50-foot level we found it 80 feet long; on the 150-foot level we found it 117 feet long, and on the 212-foot level we found it 203 feet long, as proved by actual workings. From this mine we have extracted 1,535 tons, averaging $31.52; total, $48,389.64. The Foot Wall ledge, parallel and distant from the Hanging Wall ledge 32 feet northerly, is said to have been the richest of the two veins when formerly worked. We have extracted 31½ tons, which milled $19.13 per ton. On the Hanging Wall ledge we have attained a depth of 321 feet, and are ready for starting off our 312-foot levels, with a 12-foot sump, and shall be ready to commence stoping. The ore in the shaft, from the 212 feet to the present depth, has been uniformly good. The ledge is about 20 inches (average) in size.

The two principal mines of the company, (the Saint Patrick and the Crater,) situated 135 feet apart, have separate engines, supplied with steam from the same boiler, using only half a cord of wood per twenty-four hours.

The Saint Patrick mill contains 15 stamps of 650 pounds each, fed by Cochrane's automatic self-feeder; stamps drop 60 per minute; fall from 8 to 10 inches; crushing capacity—using No. 6 punched screens—20 tons per twenty-four hours.

The mortar, below the discharge inside front, has a strip of copper 19 inches. Five-eighths of the gold product is caught in the mortar. From the discharge the pulp flows over broad aprons or copper plates; these catch two-sixteenths of the product; thence over 12 feet of blankets. The blanket concentration is passed through the Atwood almalgamator, which not only acts as an amalgamator, but serves as a concentrator for the richer sulphurets and sand, which are taken off every two hours and ground in a Knox pan, yielding (the amalgamator and concentrator) one-sixteenth of the gross results.

The pulp that flows over the blankets passes through a V-box (Spitzkasten) furnished with hydrostatic pressure, admitted at the bottom, sufficiently strong to keep the pulp alive, thereby acting as a concentrator, the particles of gold and richer sulphurets remaining at the bottom, which is filled with quicksilver, the lighter sands flowing from the top. This is cleaned up daily by drawing the bottom plug, and does not stop the work an instant.

From the V-box the pulp flows into the first and second Hendy concentrators—two to each battery; thence through 30 feet of sluices 12 by 16 inches, with half-inch grade to the foot. At the bottom of the sluice there is arranged an iron gate raised by an over-shot, driven by the water and pulp that flows away. The gate is regulated to rise one inch per hour, thereby keeping back all particles that have the greatest specific gravity—gold, sulphurets, or auriferous sand. The box filling in twelve hours, the flow of pulp is turned into a companion sluice, and the contents of the full box shoveled into a rocker and concentrated. These concentrations with the Hendy concentrators are ground in a Wheeler pan, from which is obtained the three-sixteenths of the total yield. From the pans the pulp or slimes pass to a slime-pit, where it is reconcentrated, shoveled out, and stored up eventually to work by chlorination. The motive-power of the mill is steam.

It now costs the Saint Patrick Company $2.68 per ton to mill the ores; but it is estimated that by the use of water-power the expense would be reduced to $1.50 per ton. The sulphurets are reserved for treatment by chlorination. It is estimated that 60 per cent. of the value of the sulphurets are obtained in the pans after the system of reconcentration adopted here.

I condense the following from the report of the Saint Patrick Mining Company for 1873:

Receipts:

Bullion account	$56,064 09
Milling ores	2,743 33
Assessments 6 and 7	20,000 00
Cash on hand last year	1,591 15
Other sources	3,933 65
Total	84,332 22

Disbursements:

Mill supplies	$8,181 76
Mill construction and repairs	3,663 16
Mine supplies	7,695 05
Mine labor	34,506 14
Mill labor	9,216 37
Salaries	3,600 00
Mine property	6,000 00
Book accounts	1,523 38
Incidentals	6,946 36
Total	84,332 22

The Saint Patrick, Crater, Spanish, and Gold Blossom, comprising an aggregate of 4,600 feet on parallel ledges, belong to this company. The operations for the year ending July 1, 1873, are reported as follows: number of tons raised, 3,149; worked, 3,000 tons in the company's mill; average yield per ton, $20; total bullion product, $60,000; number of stamps employed, 15; cost of milling, $2.68 per ton; miner's wages, $3 per day; number of miners employed, 12.

The Mina Rica Company, situated one mile east of the Saint Patrick, in the metamorphic slate belt, has a well-defined but narrow ledge running northeast and southwest, and standing nearly vertical, with a slight dip to the east. The mine is developed by a main shaft 155 feet deep, and two levels run northerly, on the course of the ledge.

The slate on the west, forming the main body of the hill, is talcose; on the eastern side of the vein it is more indurated. The vein occurs at the junction of these formations. The west, or foot wall, presents a firm, smooth appearance throughout the entire length of the ground opened by the levels. The original outcrop of the vein made its appearance at a point about 100 feet north of the shaft—continuing to the summit of the hill. Along the line of outcrop the vein was worked at various points by the original owners, and a shaft was sunk 60 feet, to the level of the north upper drift. This shaft, and a small quantity of ground stoped on either side, yielded $15,000—mostly in free gold. This ground was located in 1865, and has been worked at intervals since that time by different owners, with the varying results incident to the opening of quartz-mines. The surface croppings on the slopes of the hill north of the shaft were worked by former owners with highly remunerative results, by "gouging" the ore to a depth of 6 or 8 feet, but no effort was made by them to develop the ground in depth by permanent works. The property passed into the hands of the present company in 1869, since which time about $20,000 has been expended in the development of the mine by the erection of hoisting and pumping works, sinking working-shaft, and running levels toward the rich ground exposed on the hillside north of the shaft.

During the summer of 1873 the bold outcropping on the summit of the hill north of the shaft, which seems to have been overlooked by the original owners in their surface exploration, was examined, and proved to contain a high grade of ore, one of the most remarkable features of which was the predominance of silver. Assays of selected rock from these croppings, made by Messrs. Riotte & Luckhardt, of San Francisco, gave the following results: Silver, $529; gold, $3.87. Subsequently these gentlemen made a working test of 300 pounds of ore from this point, the pulp assay of which showed: silver, $94.25; gold, $3.76. The occurrence of a large percentage of silver in the gold-bearing quartz-veins of California has been brought to the attention of the public by Almarin B. Paul, in an article quoted in my report for 1871-'72, p. 18, where the results of assays from several mines are given. In Auburn and Ophir districts the surface croppings of silver-bearing quartz are usually succeeded, as depth is attained, by free-gold-bearing quartz. The Mina Rica Company has hoisting and pumping works over the main shaft of sufficient power to raise 60 to 80 tons per twenty-four hours. These works are run by a twenty-four-foot overshot wheel, using 20 to 30 inches of water, (miner's measurement,) at an expense of $1.50 per day.

The Green Mine, noted for the extraordinary productivenes of a chimney worked during 1871, which yielded $150,000, is situated between the Saint Patrick and the Mina Rica. Work will be resumed on this and the Mina Rica Mine early in 1874.

The condition of quartz-mining in this district will be shown by the following exhibits:

List of producing mines in Auburn and Ophir districts, Placer County, Cal., reported by James H. Crossman, superintendent Saint Patrick Mine.

Name.	Owner.	Location.	Course.	Dip.	Dimensions. Length.	Dimensions. Thickness.	Development. Depth main shaft.	Development. Total length drifts.	Country-rock.	Vein-matter.	Average value per ton.	Per cent. sulphurets per ton.
				°	*Feet.*	*In.*	*Feet.*	*Feet.*				
St. Patrick	St. Patrick Company	Ophir district	E. & W.	45 S.	1,500	20	320	425	Trap-cap, granite underlying	Quartz	$41 50	2½
Crater		do	E. & W.	43 S.	600	20	235	300	Syenite	do	42 00	3
Spanish		do	N. & S.	38 E.	1,000	36	150	290	Metamorphic slate, covering granite	do	9 00	2½
Gold Blossom		do	N. & S.	78 E.	1,500	30	70	120	Metamorphic slate	do	7 50	1½
Mina Rica	Mina Rica Company	Auburn district	N. & S.	85 S.	2,000	18	155	585	do	do	15 00	2½
St. Lawrence	do	Ophir district	N. & S.	43 S	2,000	24	180	500	do	do	7 50	1½
Buckeye	Bellevue Mining Co.	do	E. & W.	65 S.	2,000	15	178	420	do	do	32 50	2
Elizabeth		do	E. & W.	58 S.	2,000	20	80	82	do	do	28 00	2
Cooper	Cooper & Co	do	E. & W.	45 S.	1,000	20	85	120	do	do	22 00	2½
Scott	Scott & Co	do	E. & W.	80 S.	1,000	8	80	250	Syenite	do	20 00	1
Holder	Holder & Co	do	E. & W.	80 S.	1,000	8	60	150	do	do	30 00	1½
Shady Side	Puffer & Co	do	E. & W.	80 S.	1,000	8	60	100	do	do	50 00	1
Auburn	Auburn Orleans Com	Auburn district	N. & S.	45 E.	2,000	30	180	300	Metamorphic slate	do	15 00	1
Solaie	Charles Swan & Co	do	N. & S.	45 E.	1,500	12	220	160	do	do	40 00	0½
Consolidated Mines	Godard & Co	Ophir district	E. & W.	32 S.	1,500	20	190	210	do	do	10 00	1
Orleans	Orleans Company	Auburn district	E. & W.	45 S.	3,000	36	82	80	do	do	15 00	8
Crandall	do	do	E. & W.	45 S.	3,000	36	160	100	do	do	6 00	4
Julian	do	Ophir district	N. & S.	60 E.	3,000	36	230	800	Syenite	do	8 00	2½

List of mills in Placer County, Ophir district, California, reported by J. H. Crossman.

Name of mill and owners.	Location.	Power, steam or water.	Horse-power of engine, or diameter of over-shot wheel.	Number of stamps.	Weight of stamps, lbs.	Number of drops per minute.	Height of drop, inches.	Number and kind of pans.	Number and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours, cords; or water, in miner's inches.	Crushing capacity of mill per 24 hours, tons.	Loss of mercury per ton.	Cost of treatment per ton.	Running time, months.
St. Patrick Gold-Mining Company.	Empire City	Steam	40 H. P.	15	750	60	8 to 10	1 Wheeler 1 Knox	6 Hendy 3 V-boxes Self-acting sluices and rocker.	$20,000	3 cords	28	2 oz.	$2 00	8
St. Lawrence	Ophir	Water	30 feet	6	750	70	8	Arastra	2 Hendy	10,000	100 inches	12	......	1 00	3
Pugh	do	do	do	4	600	70	8	do	Blankets	5,000	do	10	......	1 00	10
Julian	Jenny Lind Flat	Steam	40 H. P.	20	650	75	8 to 10	1 Wheeler	8 Hendy	28,000	3 cords	30	......	2 00	3
Shiply	Shiply Ranch	Water	30 feet	10	650	65	8	1 Knox	Blankets and cradle	8,000	100 inches	15	......	1 00	...
Quin	Gold Hill	do	do	4	600	60	8	......	Blankets	4,000	do	6	......	1 25	4

REMARKS.—The concentrations are usually ground in Wheeler pans at a cost of $6.50 per ton, the slums from the pan being reconcentrated in slime pits and vats, and piled up for future working by chlorination.

The Rising Sun, near Colfax, in Illinoistown district, is a well-known producing mine. During the year ending July 1, 1873, it produced 2,600 tons of ore, which yielded in the company's mill, (5 stamps,) $70,000, or about $37 per ton. The cost of mining is $3.50; of milling, $3 per ton; miner's wages, $3 per day; 25 miners employed. The mine is between 400 and 500 feet deep, with a well-defined vein of good ore in the bottom of the shaft.

Although Placer County possesses, in the vicinity of Dutch Flat and Gold Run, some of the most extensively developed hydraulic and gravel-mining properties in California, the area of these developed districts is insignificant compared with the vast extent of partially explored ground situated in the elevated mountainous region, between the North and Middle Forks of the American River, of which, comparatively, only the surface or upper stratum has been gleaned, and that only at places favorably situated for outlet or fall, without the construction of long and expensive bed-rock tunnels. Nearly the entire area between these streams is a mass of auriferous dirt and gravel; and within these limits are the once populous towns of Forest Hill, Michigan Bluff, and Iowa Hill, now in a state of decline, not in consequence of an exhaustion of the mines, but owing to the want of the water facilities now considered necessary, since the introduction of the improved hydraulic apparatus, for the removal of the extensive masses of auriferous dirt and gravel which lie in parallel belts between these mountain streams, whether existing in so-called "ancient river channels," or as a vast mass of accumulated detritus, is still a matter of conjecture.

This once productive region has been visited during the present summer by Dr. J. M. Willey, of San Francisco, who read before the California Academy of Sciences an interesting paper in which he discusses the theory of the formation of these masses of detrital matter. Dr. Willey says:

> It is hardly necessary to say that the gravel-beds of the central counties of California are supposed to present sufficient evidence of the existence of a system of large but extinct rivers, and that the course of these ancient rivers is believed to have been oblique, and often at right angles to that of the present streams, and to their tributaries flowing through the various cañons which have their sources on the western slope of the Sierra Nevada range.
>
> Although it is possible that such a mode of explanation may account for even so widely spread a deposit of gold-bearing gravel as exists in Placer and adjoining counties, I think there are certain features in this deposit difficult to reconcile with the theory of the ancient river system, and that the close study of the subject reveals a problem of a very complicated though interesting nature. The first thing which arrests the attention, after looking at the large excavations which hydraulic power has worn in the gravel-banks, in some places leaving precipices from one to two hundred feet deep, is the profusion of bowlders of pure quartz which cover the worked-out portions of the ground. These bowlders lie on the bed-rock in some places many feet in depth.
>
> At Forest Hill and Michigan Bluffs the eye is dazzled in the sunlight reflected from heaps of round quartz, some masses of which will measure several cubic yards.
>
> The smaller bowlders are in general washed away, but I looked with surprise at one portion of an unworked bank at Michigan Bluffs, observing that it was composed almost entirely of quartz fragments from pebble size upward, all having the usual rounded or ovoid form.
>
> There will be little doubt, I think, that we have here the origin of the gold which occurs so plentifully in connection with the gravel of this section of country, but the question remains as to how the attrition has been performed which liberates it.*
>
> What tremendous powers have, in the first place, dislocated from their original casings the gold-bearing quartz ledges, and, in the next, ground to so perfect a smooth-

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*It cannot be demonstrated that these water-worn bowlders and pebbles of quartz contain gold in paying quantities, with very rare exceptions. Practical assays and working tests of such accumulations of bowlders have generally proved them to be barren.—W. A. S.

ness and rotundity the hardest specimens of white, blue, and rose-colored quartz fragments?

Mere fluvial action, however violent, will not at all account for the first condition even if it does for the second. Granite, in the Placer County gravel-beds, occurs only in bowlders associated with the quartz and that sparingly, the bed-rock being universally a slate; and in this respect the difference between the placer-diggings of Idaho Territory and those of Central California is very remarkable. In Idaho the bed-rock is everywhere granite, and the ledges which have supplied the gold are often distinctly traceable, good diggings being found below them, as in Granite Gulch near Placerville, and none at all above.

To what then shall we refer the disruption in California of that primitive relationship of rocks which we find still remaining in Idaho?

Perhaps volcanic action may account for it, and in connection with this view I wish to present to the notice of the society a specimen of the peculiar substance called cement. [Known by the miners as pipe-clay.] This substance occurs very abundantly in distinct, and sometimes alternate, stratification with the gravel in most of the Placer County mines; in fact, in all of them which I had an opportunity of visiting. It does not, so far as I could see, mix with the gravel, but is often of such a depth and hardness as to seriously embarrass the operations of the miner. Being entirely barren it has sometimes to be blasted with powder or nitro-glycerine before the hydraulic stream will act upon it, and then adds greatly to the cost of hydraulic operations.

It is a grayish-white, and so homogeneous, apparently, in its nature, that the miners generally call it pipe-clay. Although this whitish color is the usual tint, I have observed it in some situations to be of various shades of brown.

Now, is this substance a volcanic ash; and if not, what is it?

I think the answer to this question carries with it a solution of much of the difficulty in accounting for the condition of things in Central California. Admitting that this cement is a true product of volcanic eruption, the large extent of surface covered by it, and its frequent great depth, would lead us to infer an enormous amount of volcanic activity, perhaps in connection with the elevation of the neighboring peaks of the Sierra Nevada range.*

Mr. Hanks kindly afforded me a microscopic examination of the present specimen, and it appears to resolve itself into the three elements of granite, quartz, mica, and feldspar.

After due consideration of the effects of prolonged action of the surf on both salt and fresh water beaches, in the production of such gravel and boulders as we see in Placer county, I doubt whether the ancient river system can be taken into the question, or is so clearly traceable. There is one other mode of explanation of most, if not all, the phenomena alluded to, which I think deserves attention. I refer to the grinding and comminuting power of glacial action.

Of all the forces of nature which effect transformation of the surface of the earth the progress of glaciers is among the most potent. Every year brings new proofs of the extent and importance of the changes effected by glacier movements, and perhaps investigation may show that there was a time in which, from the western slopes of the Sierra Nevada range proceeded icy masses, of a magnitude and weight sufficient to have crushed out and destroyed the original relationships of rock over which they traveled, and to have had much to do with, if they were not the principal cause of, the disrupted and almost chaotic state of things in Placer county.†

Several years since Col. A. W. Von Schmidt, of San Francisco, and associates, organized a project for tapping Lake Tahoe and bringing its waters, by means of flumes, tunnels, and ditches, through this rich mining section, and eventually to the great valleys of California, the San Joaquin, and Sacramento, for purposes of irrigation and the supply of the principal cities with pure water. This project seems, however, to be dropped, as it was considered premature, and involved too great an outlay; and one of less magnitude, but of equal importance to the miners of the divide between the North and Middle Forks of the American, has been inaugurated within the present year. This contemplates the acquisition of large tracts of mining ground and important water-rights. The project involves the damming of the waters of the Middle Fork of the American River near its source; the building of large reservoirs, and a ditch sixty miles in length. The water is to be carried down to Iowa Hill, Yankee Jim's, Wisconsin Hill, Little York, &c. The region is very rich in auriferous deposits; but scarcity of water has hitherto prevented the development of its resources. By means of the main ditch and its branches 5,000 inches of water per day can be introduced, which will admit of a sufficient number of claims being worked by hydraulic and other processes in which water is the chief element used, to give work to from one to two thousand men. The result will be a permanent revival of mining. Some $250,000 has been already expended in the purchase of various water-rights and mining claims. It is anticipated that the ditch and reservoirs will cost about $450,000, and that they can be completed within about a year and a half.

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* The substance called "pipe-clay" is nothing more than a sedimentary layer deposited during periods of overflow of the ancient rivers, and in no respect different from the layers or strata of mud deposited during the periodical overflows of the Sacramento River, over large extents of country near its banks. The volcanic ash, so common in the higher Sierra, and forming a capping of the ancient rivers, is of entirely different appearance and composition.—W. A. S.

† I have quoted freely from Dr. Willey's paper, since the subject is of great interest to all engaged in mining, and am disposed to agree rather with his conclusion than his premises as regards glacial action, though this probably occurred at some very remote period, anterior to the excavation by fluvial action of the so-called Pliocene rivers. The fact of the non-existence of gold as a general rule in the quartz bowlders and pebbles does not necessarily disprove the theory that the quartz ledges, broken and ground by glacial action, and subsequently rounded and polished by the action of swift-running water, were not the original matrices of the gold, since we are aware that only small portions of the quartz ledges now worked are auriferous, and the great mass of quartz is utterly barren and unproductive. The disintegration of the great Mother Lode, from similar causes, would present the same phenomena.—W. A. S.

Another enterprise of a similar nature, contemplating the diversion of the waters of the North Fork of the American, is now in operation, and $60,000 has already been expended. Before the close of 1874 the water facilities of the divide will be greatly increased.

The vicinity of Dutch Flat, in Placer County, on the line of the Central Pacific Railroad, has been noted since 1851, as one of the richest of the alluvial gold deposits of California, and since the improvements in hydraulic mining, has been the scene of operations on a large scale. The contents of the deep-lying channel at this point vary from six to eight hundred feet in breadth, with a gravel-belt of much greater width spread out over its banks on either hand.

The portion still remaining unworked ranges in depth from 150 to 200 feet, the greatest depth being over the middle of the channel, which runs nearly parallel with Bear River. This channel, as is usually the case, is walled in on either hand by steep rocky sides. It happens at Dutch Flat, as is often the case elsewhere, that the rim-rock comes in places quite to the surface, denoting by its presence the extent of the channel laterally. To the stratum of gravel lying next the bed-rock and occupying the lowest portion of these Pliocene rivers the term *blue lead*, because of its color, has been applied by the miners. This material, in addition to its color, is characterized by an unusual degree of hardness and the large amount of gold it often contains.

In many localities these auriferous banks are covered by deep beds of ash, lava, basalt, or other volcanic flows, rendering the work of mining them difficult, or wholly impracticable; while elsewhere they are interstratified with heavy layers of pipe-clay, sand, or other barren matter, greatly interfering with the labors of the miner, and frequently defeating successful operations altogether. The ground in this vicinity is, however, entirely free from obstructions of this kind, the gravel, though of extraordinary depth, being uniform in its composition, nowhere excessively hard, and gold-bearing throughout. As is common in all of these channels, where the volume of water passing through has been large, we find here, occurring on different levels, strata of bowlders of enormous proportions.

Two methods of mining have been extensively employed at Dutch Flat: hydraulic-mining, by which the entire body of gravel is torn down, and, having been relieved of its precious contents, is afterward washed away; and drifting, by which only the richer stratum at the bottom is removed and manipulated, recourse being had for the purpose to shafts and tunnels. The gravel taken out by drifting is afterward washed in sluices, or, if extremely hard, is crushed to a coarse pulp under stamps, the gold being saved by amalgamation and the aid of various mechanical contrivances adapted to that end. Along the lower portion of the divide between the Cañon and Bear River both classes of operations have been largely engaged in; while farther up, work has been confined mostly to the former process. the blue lead being less favorably situated here for drifting. That it is equally as rich, however, as at points farther down, has been fully demonstrated by the prospects obtained from several shafts sunk to the bed-rock. From the bottom of the shafts drifts were run in various directions, proving the blue lead here to be deep, well stocked and widely developed.

One of the most extensive gravel-mining operations in the State is that of the Dutch Flat Blue-Gravel Mining Company, a San Francisco incorporation, owning 65 acres of gravel-ground, embracing what was formerly known as the "Taeff ground," described in former volumes of these reports, and situated on the mountain-side overlooking Bear River. Operations were commenced here on a large scale in 1872, but abandoned late in the year, owing to the original choice of what the company afterward considered an injudicious method of opening the ground, namely, from an adjacent cañon, instead of from Bear River by means of a bed-rock tunnel of sufficient depth to open the underlying strata of blue gravel known to exist on the bottom. During the present year the property has been examined by J. M. Taylor, mining engineer of San Francisco, who has made an elaborate report, from which the following extracts are taken. Mr. Taylor says:

> Along no portion of the blue lead, perhaps, has a better showing of gold ever been made than at this point, the gravel taken out prospecting at the rate of $10 and even as high as $20 per cubic yard. It was found to be of the unusual depth of 30 feet, and, though not inordinately hard, is impacted to a degree that will probably render the use of stamps or other machinery necessary to its economical reduction.
>
> The principal prospecting shaft sunk here was put down on the westerly border of the company's ground at a point supposed to be near the center of the old channel. It was carried down 225 feet to the bed-rock and drifts pushed north and south from its bottom, crossing the blue lead at right angles. A tunnel 400 feet in length, flumed and out-fitted with riffles and under-currents, was run from the cañon intersecting this shaft near the top. This tunnel was constructed for running off the upper stratum of gravel, and having subserved that end, is no longer of any use.
>
> Under the hydraulic workings carried on here during the past sixteen years, a stratum of top-gravel has been washed away from the entire surface of this tract to an average depth of 75 or 80 feet, this being as low as the gravel could be run off owing to the interposition of the rim-rock: nor can washing operations be resumed until an outlet has been supplied either by cutting an open passage through the upper edge of this rocky barrier or by the construction of a tunnel through it on a lower level. As the first expedient would afford only temporary relief, the plan of driving a bed-rock tunnel through which the entire contents of the channels can be run out has been adopted by the company.
>
> A suitable site for an adit of this kind has been fixed upon and the work of excavation, with other preliminary labors, commenced. The spot selected for the mouth of this tunnel lies on the Bear River side of the ridge, whence the adit will be driven in a southerly direction on a level that will bring it under the center of the old channel, 75 feet below its bottom. It is calculated that this point will be reached in running a distance not to exceed 800 or 1,000 feet at the most. This tunnel is designed to be 6 feet wide and 8 feet high, and to be run on a 12-inch grade. Its mouth will be 150 feet above the bed of Bear River, precluding the possibility of any troublesome accumulation of tailings in the future working of the mine. The rock to be penetrated is supposed to be composed mainly of a clay-slate, solid enough to stand without timber-

ing, and yet not so hard as to greatly retard the work of excavation, which is to be expedited by the services of a machine-drill. The motive-power for driving this drill will be supplied by water to be conducted upon a hurdy-gurdy wheel at the mouth of the tunnel through a pipe connecting with the company's main. This pipe, 6 inches in diameter, and 1,500 feet in length, has already been laid down. Through the aid of this machine, which is to be operated on the lower face of tunnel, I am of the opinion that the latter can be completed in the course of seven or eight months from the time work is resumed upon it, and at a cost not to exceed $35 per linear foot. As a means of further hastening this improvement, work by hand-drilling might at the same time be advanced from the shaft-face at the upper end of the tunnel, as an opening of this kind will be required at that point for the passage of the water and the gravel when washing shall have been begun. A rock-paved flume without gold-saving appliances will be put down along the tunnel, the latter being designed simply as an adit for the running of the slums, to which end an unusually steep grade has been imparted to it.

As soon as sufficient space shall have been washed off on the bed-rock to make room for a structure of the kind, a cement-mill will be put up in the piping-pit for crushing the indurated contents of the Blue lead, the probability being that a stratum of bottom-gravel from 10 to 15 feet in thickness and from 500 to 600 feet in breadth will have to be subjected to this or some similar mode of treatment in order to secure the gold it contains. At the start, the plan of crushing this substance to a coarse pulp under stamps, without any attempt at first separating the hard and barren from the productive material, was generally practiced. Then the method of running it through a device known as the Cox pan, whereby the rock and coarser gravel were separated from the gold-bearing cement before being passed under the stamps, came into vogue; and latterly this machine has in some instances been made to perform this entire service, dispensing with the use of stamps altogether. As the amount of gravel disposed of can be greatly increased by the employment of this pan, it may be expected to generally supersede the use of stamps, while it reduces at the same time first cost of washing fully one-half. The capacity of the cement-crushing apparatus, whatever the style of machine adopted, will be regulated by the necessities of the case, the object to be attained being the advancement of this branch of the work as rapidly as the body of gravel above is washed away. The machinery here will also be propelled by a portion of the water supplied to the mines. A hunded inches acting under so great a pressure will no doubt be found sufficient for the purpose. This mill will discharge its tailings through the shaft into the tunnel, to be carried along with the hydraulic slums over the gold-saving appliances below, where any particles of the precious metal left in them will be arrested and saved.

The plant connected with this property consists of 2,450 feet of iron pipe, the main trunk 30 and the throat or inlet at its head 60 inches in diameter. This pipe, which was laid down in 1872, conducts the water to be used in washing from the South Yuba Canal, upon the company's claim. Connecting with this are two smaller pipes for conveying the water to points where required for use, one of these being 22 inches in diameter and 450 feet long, and the other 18 inches in diameter and 400 feet long. These distributing-pipes have capacity to carry 2,000 inches of water, which, being discharged through two 6-inch giant nozzles under an average pressure of 450 feet, supply a power unparalleled in the history of hydraulic mining.

The apparatus put in place here is in every respect equal to any other ever laid down in the State, being of extra large size, built of the best material, and modeled after the most approved patterns extant. In the absence of a bed-rock tunnel, these appliances have as yet been operated barely enough to test their efficiency and strength, they being in no sense any the worse for use. The cost of these pipes, including freights and the labor of putting them down and the furnishing of nozzles, discharge-boxes, distributers and other necessary appendages, has amounted to the sum of $26,000. After these costly appurtenances had been added to the property, it was found impossible to get sufficient grade to run this large amount of water to advantage without a deep-lying outlet, wherefore washing operations have been suspended until a work of this kind shall have been constructed.

"About one-third in bulk and one-tenth in value of their original stock of gravel has been disposed of, while the balance has been thoroughly prospected and proven, the Blue lead, together with the great mass of their richer ground, remaining untouched.

"The gravel already piped away from the surface of this tract yielded at the rate of 75 cents for every inch of water used during a run of ten hours, or, in other words, from 30 to 40 cents for every cubic yard of gravel run off. The top dirt here is notoriously poorer than the deeper-lying strata, the increment of gold, as all experience shows, being in the direct ratio of depth attained."

Mr. Taylor makes some interesting statements of the product of this and other ground in the vicinity, which are confirmed from personal knowledge by Mr. Skidmore.

In sinking the prospecting shaft mentioned, every foot of the earth was carefully

> and thoroughly examined and found, under the most crucial tests, to yield an average of 2 cents to the pan, being at the rate of $2 to the cubic yard from top to bottom. From the group of claims situate near the lower end of the ridge, but on the same channel, and about half a mile distant from this company's ground, the Blue lead was drifted out at an early day, and, although we have no specific figures as to the amount of gold that was extracted from them, it is known to have been extremely large. At several other points along this channel, ranging from two to six miles farther north, sections of the old Blue lead have been worked either by hydraulic washing or by drifting, and invariably found to yield well. On the Neece and West claim near the town of You Bet, the Blue lead, from which the top gravel had first been piped off, turned out $1,000 for every linear foot along it, while from the Brown claim, lying near by and worked by drifting, $600,000 was taken from an area on the bottom of the old channel but a little over 400 feet square. At Indiana Hill, four miles to the southwest, but on the same channel passing through Dutch Flat, the contents of the Blue lead, crushed under stamps, yields at the rate of $7.83 to the cubic yard.

Mr. Taylor estimates that it will require a working capital of $75,000 to properly open this ground and provide the necessary appliances. Of this sum, $35,000 is estimated as the cost of the tunnel, which is probably too low, as the rock is extremely hard. He further estimates that, with all the appliances recommended, the company have a supply of gravel which cannot be exhausted in less than twenty-five or thirty years.

The water-supply at this point is assured through the construction of three large ditches, having an aggregate capacity to carry 8,000 inches of water. These capacious hydraulic works pass within half a mile of Dutch Flat, and at an elevation that enables the miners to play their pipes under a head of 450 feet, a pressure that will hereafter be increased to 500. The proprietors of these ditches furnish water at the low price of 12½ cents per inch for a run of twenty-four hours, and there is a likelihood of the water-rates here being still further reduced.

Three miles southeast of Dutch Flat, and on the same belt of auriferous gravel, is the mining town of Gold Run, the seat of several of the most important mining operations in the State. Among these is the Cedar Creek Mining Company, a London company, owning a large extent of ground on the channel on the eastern slope of Indiana Hill, overlooking the great cañon of the North Fork of the American River, which has here cut its way through the slates to a depth of 2,000 feet, thus affording ample outlet for miles of gravel-deposits in this district.

This company started a bed-rock tunnel last July, to run from the mouth of Dutch Flat Cañon to the Deep Shaft claim, a distance of about 3,000 feet, for the purpose of washing to the bed-rock all of the rich deposit overlying the ancient channel, under which it will pass. This tunnel is being run by hand at present, but a Burleigh drilling-machine is now on the way, which, when it arrives and is set up, will press the work onward at a rapid rate. The motive-power for the drill is compressed air, led through an iron pipe into the tunnel. The machinery will be driven by water-power, of which the company have plenty for this purpose the year round, the pressure at this point being 750 feet. Aside from the rock in the face of the tunnel, four shafts are to be sunk—one of which is already down about 140 feet—and the tunnel run from them, it being the intention to run from eight faces, so as to complete the tunnel as soon as possible. The face of the main tunnel is now in about 200 feet, and it is expected will be completed in 1875. This is quite an important enterprise, as all of the surface-gravel had been washed off.

The subject of the utilization of the vast accumulations of hydraulic and placer tailings which exist in all the mining regions of California, and nowhere in greater quantities than in Placer County, has attracted the attention of miners within the past two years, and the problem whether they can be successfully worked will soon be solved. Bear River, Greenhorn, and the tributaries in Little York Township are filled up to the depth of many feet with such accumulated *débris* of hydraulic washings known to be rich in gold. These streams, with their branches, form outlets for the rich mines at Dutch Flat, Little York, You Bet, Chalk Bluff, Quaker Hill, Hunt's Hill, Buckeye Hill, and Gold Run, while the tailings of many quartz-ledges find their way into the river. This gold is shut up for want of an outlet, and, in addition, many rich claims on the Blue lead and its branches cannot be worked. The project for developing these deposits of gold has been inaugurated by the Bear River and Chalk Bluff Fluming, Ditch, and Mining Company in San Francisco.

This company has acquired some 8,000 acres of land, located in Little York Township, rich in gravel leads, and through which branches of the Blue lead pass. In addition to this they have obtained the outlet of all this vast and rich territory, extending down into Bear River. The company proposes to run a tunnel from the North Fork of the American River to Bear River, on a grade of one foot in twenty-four, which will be on the American side 250 feet above the bed of the river. The tunnel is to be 9 feet high and 12 feet wide, affording room for a double set of large sluices, and it will be 12,000 feet long. The outlet will be below Cape Horn, near the line of the Central Pacific Railroad. It is estimated that this tunnel can be run in two years, and that it will cost in the vicinity of $600,000.

Mr. Frederick Mow, the engineer of the Bear River Tunnel Fluming and Mining Company, estimates, from careful surveys and measurements, that there are now lodged in and along that portion of the several streams embraced within the limits of the company's claims a quantity of this gold-bearing *debris* equivalent to 49,281,644 cubic yards. This mass of material is ascertained to have accumulated to an average depth of about 50 feet, and to have spread out to a mean breadth of 240 feet, along a linear distance of twenty-three miles. It covers a total area of nearly one thousand acres, distributed as follows: In Bear River, 17,874,340 cubic yards; in Steep Hollow, 7,174,900 cubic yards; in Main Greenhorn Cañon, 14,564,186; in Missouri Cañon, 2,540,963; in Little Greenhorn, 3,918,400; in Arkansas Ravine, 1,740,643, and in Green Mountain Cañon, 1,468,212 cubic yards.

The company's engineers make the following estimate of the contents of the accumulations of Bear River:

> Beginning at the lower end of your company's claims on Bear River, it may be estimated that the first five miles of tailings, measuring up-stream, will yield 30 cents to the cubic yard, giving a gross product for this section of $3,507,420, and that the remaining eighteen miles will yield at the rate of 60 cents per cubic yard, making an additional sum of $25,253,424, and a grand total of $28,760,844, to which should be added the further sum of $3,000,000 to represent value of quicksilver saved and product of sand and sulphurets. With these tailing-deposits once thoroughly outfitted and work fairly under way, it may be calculated that a section of two miles, beginning at the lower end, can be run off the first year, and three miles every year thereafter. Disposing of your material at this rate, your revenues for the first year should amount to $1,402,968, for the second year to $2,104,452; and for each remaining year thereafter to $4,208,904.
>
> The cost of running the Company's Bed-rock Tunnel, including shaft and inclines, purchase of machine-drills, &c., should not, with the facilities now at hand for cheapening work of this kind, exceed $30 per linear foot, or a total of $376,200. The cost of lumber and laying down the flumes necessary to the commencement of operations—that through the tunnel included—will amount to about $10 per linear foot, making for the whole say $140,000; while for the purchase of material, construction, and outfitting the gold-saving department, an additional sum of $20,000 should suffice, making a total preliminary expenditure of $536,200.

Concerning these estimates, I can only say that I believe the average contents in gold of the accumulated tailings are greatly overrated; but 5 per cent. may be deducted, and still leave a good margin of profit for the enterprise. Moreover, such a tunnel would drain Bear River, and would be of incalculable advantage in the working of mining-ground above the mouth of the tunnel, which it is now impracticable to work for want of outlet, in consequence of the filling up of the minor tributary streams.

The Gold Run Ditch and Mining Company, of Gold Run, in this county, is engaged in an important undertaking, having for its object the "bottoming" (developing with a deep tunnel) of the deep places of Gold Run district. Mr. H. H. Brown, the superintendent, communicates the following facts:

> We commenced constructing our bed-rock tunnel in September, 1872, and made but slow progress until last August, when we put in two Burleigh drills, run by compressed air, and are now (December, 1873) making 3¼ feet in twenty-four hours in the hardest kind of rock, using XX Hercules powder as an explosive. The object of this tunnel is to furnish an outlet to all of the mines in Gold Run district east of the Central Pacific Railroad. The tunnel to reach the Blue lead or channel will be 2,200 feet long, 12 feet wide, and 9 feet high. We intend to put in two 5-foot flumes. We shall tap the Blue lead 70 feet below any point reached before, and 270 feet below any point where washing has been done. About 500 feet from the lower end of the main tunnel we are going to run a branch, diverging to the left, 7 feet wide and 7 feet high, to reach the celebrated Indiana Hill claims, which our company now owns. This branch will be 1,135 feet long, and will tap that claim 247 feet below any point that has now been marked off. We expect to complete the entire work within two years, at a cost of not less than $100,000.

The Pioneer Fluming Company, in Shirt-tail Cañon, has one of the most extensive tailing claims in the State of California, comprising 20,000 feet in length in the cañon from the falls, up to the mouth of Refuge Cañon, and from thence up Refuge Cañon, some 1,400 feet, extending from bank to bank above high water. It originally constituted twelve separate mining-claims. This cañon is the natural outlet for a large area of country, including some of the richest hill-claims in the county, and embracing the rich washings from Yankee Jim, Wisconsin Hill, Elizabeth Hill, &c. The gravel in most of these claims is so mixed with hard cement that it cannot be freed, except by stamps, or by long exposure to the action of air or water, when it slacks and liberates the gold. The immense quantities of tailings which have come down through these cañons have been accumulated by the aid of dams, and thus stopped on their way to the American River. Some twelve years or more have elapsed since the natural bed of the stream has been seen. These tailings have accumulated in Shirt-tail Cañon to the depth of from 30 to 50 feet, while in many places the bottom, which proved at other points so immensely rich in early days that the name of the cañon became famous in the annals of California, has never been cleared up. The amount of water running through this cañon at its lowest stage is about 500 inches. In the winter it is increased to a torrent, requiring a flume of the full width of the cañon to carry it. The present company is composed of capitalists of San Francisco, and has expended a considerable sum in putting in a solid and substantial flume, capable of resisting the winter floods, and at the same time of washing through everything that comes down. At low water this stream is fed from the ditches that convey water to the above-mentioned hill-claims. After use the water falls into this cañon. It is estimated that the quicksilver which has escaped from the hill-washings and settled in the cañon is quite sufficient for all the purposes of amalgamation in reworking the tailings. The claim is of such an extent that it will take many years to wash the tailings through. Riffles, undercurrents, flumes, &c., of the latest and most improved forms, have been adopted by the company, and no energy will be spared in pushing the work as rapidly as possible. It is under the superintendence of Mr. J. R. Glover.

NEVADA COUNTY.

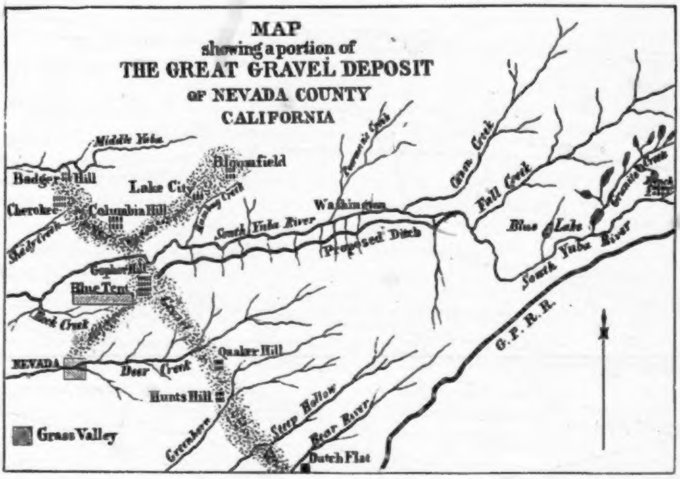
Within the limits of this county are embraced some of the most extensively-worked hydraulic and gravel claims in the State, among which may be enumerated the North Bloomfield, Union, Blue Tent, Milton, and Sweetland Creek, all of which may be considered as representative claims in this class of mining.

One of the most important of the gravel-channels at present known in the State is in Nevada County, between the South and Middle Forks of the Yuba River. Certainly the amount of gold which has been taken from this channel during the past twenty years will far exceed that from any other similar deposit.

Upon the high ridge dividing the two forks of the Yuba, and varying from 500 to 1,500 or more feet above the bed of the modern streams, a vast channel of gravel is found, which follows the general course of the ridge from Eureka to French Corral, a distance of about thirty miles. At a few points this channel is exposed on the slope of the rivers, and at these points, being easily approached, it has been extensively worked, as at Snow Point, Moore's Flat, Woolsey's Flat, Badger Hill, San Juan, Sweetland, Sebastopol, and French Corral, upon the Middle Yuba, and at Relief Hill and Grizzly Hill, on the South Yuba. It has also been largely worked at various places upon the tributaries of the South and Middle Yuba, as at North Bloomfield, Kennebec Hill, Columbia Hill, Cherokee, Chimney Hill, and other places. In most of these places mining has been confined to the white or top gravel, although at a few points the miners have been able to mine to the bed-rock, either by virtue of the nature of the approach, or with the aid of tunnels. As a general thing, the bottom of these deep channels can only be reached by long and expensive tunnels from the valleys or cañons of the forks of the Yuba or their tributaries; and in order to wash the gravel away through these tunnels water has to be brought long distances in ditches or canals at great expense.

Of the essential elements in profitable gravel-mining—auriferous gravel, abundant water at reasonable rates, and sufficient fall to enable the miner to get rid of the gravel, with facilities for the construction of tunnels to reach the bottom of the deep gravel channels—the gravel here exists in unlimited quantities; water and facilities for water-storage exist in certain localities only; and there are comparatively few places where the gravel-channel can be approached by deep tunnels at reasonable expenditure of time and money.

The mining-property of the North Bloomfield Mining Company consists of some 1,585 acres of the main gravel channel, in proximity to North Bloomfield, upon the drainage of Humbug Creek, a tributary of the South Yuba. The company also owns one-half of all the property of the Union Gravel-Mining Company, situated on Knapp's Creek, a tributary of the South Yuba, about two and a half miles below North Bloomfield, and comprising 750 acres, as well as one-half of the large and valuable property of the Milton Water and Mining Company, comprising nearly all the valuable mining-grounds from French Corral to San Juan, and the Badger Hill claims, situated on the Middle Yuba River. The company also possesses valuable water-rights and ditches.


MAP
showing a portion of
THE GREAT GRAVEL DEPOSIT
OF NEVADA COUNTY
CALIFORNIA
Middle Yuba
Badger Hill
Bloomfield
Lake City
Cherokee
Columbia Hill
Shady Creek
South Yuba River
Washington
Proposed Ditch
Canon Creek
Fall Creek
Blue Lake
South Yuba River
Gopher Hill
Blue Tent
Rock Creek
NEVADA
Deer Creek
Quaker Hill
Hunts Hill
Grass Valley
Greenhorn
Steep Hollow
Bear River
Dutch Flat
G. P. R. R.
N

Its water is taken from the headwaters of Cañon Creek or the North Fork of the South Yuba, as also from the head of the main fork of the Middle Yuba. In addition to these main sources of supply, this company also owns local water-rights from various smaller streams.

On Cañon Creek, at Bowman's Ranch, the company has constructed two large dams of a permanent character, giving a present depth of water of 72 feet. It is intended eventually to carry these dams to such a height as to give a depth of 100 feet in the reservoir. This reservoir (called the Bowman reservoir) contains at 72 feet, its present depth, above 500,000,000 cubic feet of water, equal to about 4,000,000,000 gallons.

From this reservoir the company has constructed a canal, at an expense of nearly $500,000, along the precipitous north side of Cañon Creek and its tributary, Poorman's Creek, about twenty miles, to the town of Eureka, and thence about twenty-five miles farther, on the north slope of the Yuba, to a point on the company's ground, on the mountain side, 1,000 feet above the mines. Here an expensive receiving-reservoir, called the Waldron reservoir, has been constructed. At the head of the Middle Yuba the company owns another immense reservoir, called the Ridgewood reservoir. This is formed of three very heavy dams, varying from 60 to 115 feet in height. Its capacity is about the same as that of the Bowman reservoir. The water from Ridgewood reservoir is allowed to pass down the Middle Yuba five or six miles to Milton, where another dam is built, to turn the water out of the river into a canal or ditch now constructing from Milton, eighteen or twenty miles, to Eureka, where it joins the canal from Bowman's reservoir.

When the canal from Milton to Eureka is completed the company will have a constant supply of water throughout the year of above 5,000 miner's inches, equal to 100,000,000 gallons daily.

The completion of the Milton ditch will give the company some sixty-five miles of main ditch above Waldron reservoir, costing about $10,000 per mile. The reservoirs have cost some $300,000 more; this making the cost of the main line of water-supply to the Waldron reservoir nearly $1,000,000. If to this is added the cost of local supply from purchases of water-rights, ditches, &c., the total cost of water-supply will exceed $1,000,000. From the Waldron reservoir a large canal, seven miles long, has been constructed to the Union Reservoir, to supply the mines of the Union Gravel Mining Company, one-half of which belongs to the Bloomfield Company; and quite recently this canal has been extended twenty miles farther, to French Corral, so as to supply the mines of the Milton Mining and Water Company, of which the Bloomfield Company also owns one-half. These latter canals, with their reservoirs, when completed, will have cost about $250,000; thus swelling the total cost of water-supply alone, up to fully $1,250,000, and giving a total length of main canal of some ninety miles, or, adding the local ditches, fully one hundred miles of ditch, appertaining to the Bloomfield and its associate companies, following the main ridge dividing the south and middle Yuba Rivers, and extending from the snow-line near the summit of the Sierras to the foot-hills.

The mines of the Bloomfield Company proper consist of 1,585 acres, or about two and a half miles of the main gravel channel. This gravel is from 250 to 600 feet in depth. The company has sunk prospecting shafts to the bottom of the channel, and drifted very extensively upon the bottom. These shafts developed a depth of 140 feet of blue gravel, from the bottom upward. The top or white gravel varies in thickness, owing to inequalities of surface, from 50 to 350 feet. The blue gravel is by far the richer; and the company, in one of its prospecting shafts, (where an accurate account was kept,) extracted from the shafts and drifts 30,000 tons of gravel, rock, sand, &c., out of which was taken $35,000 in gold.

The drifts upon the bed-rock from the bottom of the shafts developed the width of the channel to be about half a mile. The company during the past four or five years has washed away large quantities of the white or top gravel, to a depth of 200 feet from the surface; out of this, which contains per ton only about 2 cents in gold that can now be saved, a very large amount has been taken. Yet the immense amount of gravel washed away is but a small percentage of the vast deposit yet remaining.

To reach the large body of blue gravel which underlies the white gravel at so great a depth, the company is now running the most extensive mining tunnel within the limits of the State, and, with the exception of the Sutro tunnel in Nevada, the largest tunnel west of the Rocky Mountains. Its length from the mouth in the up-cast shaft in the gravel channel is 8,000 feet, which will eventually be extended by branches in the upper and lower boundaries of the company's ground, for a further distance of at least two miles. It commences in the deep cañon of Humbug Creek, a short distance from the South Yuba River, and follows generally the course of the cañon, some 200 feet below its bed.

It is being run by means of eight shafts, numbered from one to eight, No. 8 being the upper end of the tunnel, and situated in the mining ground where it is intended to "open out." The shafts are of a uniform size, 4½ by 9 feet in the clear, lined all the way from top to bottom with 3 by 8 inch plank, divided in the center by the same kind of plank, and well secured, making them all double-shafts, and separating the pumps from the hoisting compartment. They stand from 800 to 900 feet apart, and at an average depth of 197 feet. Heavy hoisting-works of improved form are erected over each shaft, and housed with a substantial frame building, to protect the machinery.

The machinery is driven by hurdy-gurdy wheels, varying from 18 to 21 feet in diameter, the water being brought in iron pipes from a ditch running across the company's mine and connecting with each shaft. At No. 8 it has a pressure of 240 and at No. 1 of 550 feet.

The size of the tunnel from the lower end or mouth to shaft No. 6, a distance of 6,000 feet, is 6½ feet high by 6 feet wide; from that point to shaft No. 8, a distance of 1,878 feet, it is 8 by 8 feet Work is now prosecuted from the foot of each shaft both ways, giving a total advance of from 95 to 108 feet per week. This work is all done by contract, each heading being a separate contract, and the whole employing from 150 to 175 men, who are making from $3.50 to $6 per day of eight hours. Up to this time the lower end or mouth has also been run by hand and by contract; but the company has recently put in the Diamond drill, which was used in the tunnel of the Union Gravel Mining Company, at Columbia Hill, and is expected to increase the rate of progress to about 115 feet per week. In some parts the tunnel is very wet, and the amount of water raised by the pumps at the various shafts is about 490,000 gallons per twenty-four hours. The entire length of the tunnel will be 7,874 feet, of which 2,800 feet was completed in October, 1873. Work was commenced in April, 1872, and is expected to be completed in the spring of 1874, at which time the estimated total cost will be about half a million of dollars for this work alone. To be added to this is the laying of the pipes conducting the water to each shaft, the erection of the machinery, the houses, and the tracks leading from them.

The motive-power used for hoisting and pumping at these shafts is ingenious and economical. At each shaft are erected very strong hoisting and pumping works, driven by water-power.

The water is brought from the canal of the company in a continuous line of heavy iron pipe, which passes in close proximity to the mouth of each shaft.

This line of pipe is two miles in length, and has cost, laid down, about $20,000. At each shaft a branch pipe leads to and terminates in a flexible nozzle, against what is known as a hurdy-gurdy water-wheel, some 20 feet in diameter and 6 or 8 inches face, with iron projections from its periphery. These wheels are made very strong, and being upon the main shaft, are caused to revolve very rapidly by the jet of water, under a pressure of 300 to 500 feet, thrown out of the nozzle against the iron projections or periphery of the wheel. From the main shaft the power is distributed, to hoist or pump, as required.

The following statement, taken from the books of the North Bloomfield Gravel Company, will show the expense of the construction of this tunnel from its commencement in April, 1872, up to August 31, 1873:

Labor	$151,742 63
Explosives	12,247 37
Lights	3,093 71
Steel	2,856 92
Timber and lumber	4,712 96
Sundries	8,119 43
Machinery	75,607 10
Roads, surveys, and incidental expenses	17,194 23
	275,574 35

When this work is finished, the company can reach its deep and rich blue gravel, and work its mines for from thirty to forty years. The outfit of new pipe in the works and the appliances connected therewith is very large, and has cost the company probably $30,000 to $40,000, while the sluices or wash-ways, paved with stone, which are very extensive, have cost as much more.

The present mining, which is entirely in white gravel, is carried on with nozzles 6 inches in diameter, under a pressure of 275 feet. When their deep tunnel works are completed, nozzles of 8 inches in diameter, under 500 feet pressure, will be used. It will require from 35,000,000 to 40,000,000 gallons of water daily to supply each of these nozzles up to its capacity. The force of men at work is now quite large, and the monthly pay-roll amounts to $25,000. But during the summer months of this year, (as was the case last year,) when the canals are under construction, the pay-roll will be largely increased.

These extensive works are under the management of Hamilton Smith, jr., who acts in the double capacity of superintendent and civil engineer for the company.

The works of the Union Gravel Mining Company are at Kennebec Hill. This company is composed of stockholders in the North Bloomfield, above described, and owns one and three-quarter miles on the same channel; also 8,000 feet of ground on Spring Creek, which is filled to a depth of 50 or 60 feet with the accumulated tailings of sixteen years' washings. The gravel channel, from rim to rim, is about 3,000 feet in width, with a depth of from 120 to 300 feet. Only a comparatively small portion of this ground has been worked, although washing with imperfect appliances has been carried on here for many years. The present company, being a consolidation of a large number of original locations, has opened the ground with a bed-rock tunnel, 1,620 feet in length, starting on Spring Creek, in the rim-rock, (a metamorphic slate,) and thence running at right angles to the course of the channel. At 1,620 feet from the mouth of the tunnel, an inclined shaft was raised to the surface, opening out in the old hydraulic washings. This incline dips 45° and is 220 feet long. Forty-nine feet of it was run in the rim, or country rock, when gravel was struck and followed to the surface. The pitch of the bed-rock toward the center of the channel was found to be 25°, thus indicating the existence of a large body of gravel below the lowest point attainable by means of this tunnel. This must eventually be opened by a tunnel run from the South Yuba, or some deep intersecting ravine, emptying into that stream, as in the case of the North Bloomfield Company's ground. However, the present tunnel will suffice for ten or twelve years' work, and meanwhile a deeper tunnel can be run, to tap the center and bottom of the channel. This tunnel, which was completed in October, 1873, is 6 feet wide in the clear, and 6 feet 4 inches in height; the incline being of the same dimensions. The total length of the tunnel and incline, from Spring Creek to the surface, is 1,840 feet. The tunnel is laid with a substantial flume of heavy timbers, 4 feet wide and 39 inches in height. Two of the improved nozzles, called Hydraulic Chiefs, are used. The nozzles have a diameter of 6 inches, and throw, each, 750 inches water, miner's measurement, under a pressure of 350 feet. The Union Company takes water from the North Bloomfield, in accordance with an agreement which is in the nature of a consolidation, and by which the Union surrendered a half-interest in the ground as a consideration for free water privilege. The tunnel was cut through metamorphic slate at an expense of $58,000. The greater portion was run by means of the diamond-drill. The tailings will pass into Spring Creek and thence into the Middle Yuba, 1,000 feet lower than the bed of Spring Creek. The tailings already accumulated in Spring Creek form a valuable accessory to the property of this company, in consequence of the facility with which they can be removed, and of the large amount of gold they are known to contain.

Along the ridge below the Union Company's ground are a number of claims not now worked, on account of the lack of water or outlet for tailings. Five miles below is Badger Hill, the property of the Milton Mining and Water Company. At this point, where the Middle Yuba has cut away the gravel channel and is some 700 or 800 feet below it, the Milton Company owns a large area of valuable ground. Mining has been carried forward here for many years in top gravel with profitable results. In the Badger Hill mine, the blue gravel has never yet been reached for mining purposes, although it is known to be very deep and rich. The company is now making arrangements to commence a tunnel to reach and exploit all this ground. It will be nearly a mile in length, and its execution will require probably 2½ or 3 years, although this time may be much reduced by sinking shafts upon its line, or by working with proper machinery. It is the intention to use machine-drills in this work, if the result of experiments now being made with them by the company should prove satisfactory. When the works are complete, this mine will last for twenty or twenty-five years, using 1,000 inches of water, which will, of course, be drawn from the present reservoirs and main canals of Bloomfield County.

Below Badger Hill, on a line parallel to the Middle Yuba, the gravel channel is lost for some four or five miles, having been washed away by the stream. It is again met at San Juan. Of the numerous and valuable mines at this place, some have received attention in former reports. The various claims are all at work, and the monthly yield is very large.

A short distance below San Juan is a large and valuable mining claim called Manzanita Hill, which belongs to the Milton Company. This claim, like all the others, has been worked for many years, and large amounts of gold have been taken from it. It is now being exploited steadily through the old works; but a new and deep tunnel, 2,000 feet long, is rapidly approaching completion, which will, when finished, (some time in 1874,) enable the company to mine out the entire claim, a business of many years. Some distance farther down the channel is another set of claims or mines known also to be rich. This property also belongs to the Milton Company, and is now worked through a deep tunnel nearly 4,000 feet long, recently completed, which has been some five years in progress. It was recently bought by the Milton Company at a cost of $100,000, and will serve that company for many years. It is believed, however, that another and deeper tunnel will eventually have to be constructed to permit all the ground to be worked out.

From the Bed Rock tunnel to French Corral the Milton Company also owns large and valuable tracts of the channel; and at and near French Corral, which is the lower end of the gravel channel between the two Yubas, the company has extensive mines. These well-known mines were among the earliest hydraulic workings in this State; and although they have been worked steadily when water could be obtained, and millions have been taken from them, they are still so extensive and rich that the Milton Company is constructing a new and deep tunnel half a mile or more in length, to be opened by an upcast-shaft or incline, which, when completed, will enable them to mine out the entire ground in fifteen or twenty years of steady work. The company is now mining steadily through the old workings with excellent results, and also running two large stamp-mills. The lowermost 8 or 10 feet of gravel, nearest the bed-rock of the channel, is so rich in gold, mixed with cement, that it pays well to run it all through these mills. All of these mines are supplied with water from the Bloomfield Company's reservoirs and canals.

A brief recapitulation of the approximate total cash cost of the property of these three companies, together with the estimated amount yet required to complete the works in progress, will give some notion of the extent of hydraulic operations carried on in Nevada County by what is practically a single combination of capitalists.

1st. The North Bloomfield Gravel Mining Company:	
Cash cost to date	$1,500,000
Required to complete works	500,000
2d. Union Gravel Mining Company:	
Cash cost to date	300,000
3d. Milton Mining and Water Company:	
Cash cost to date	1,500,000
Amount required to complete works	300,000
Total, (exclusive of interest)	4,100,000

If to this sum we add interest at 10 per cent. per annum upon amount invested from date of expenditure until the works are completed, the total cost will eventually reach the sum of $6,000,000, which will represent the amount of investment by these companies in two years from now, by which time, it is expected, the system of works will be complete. This large investment will constitute the ownership eventually, by one consolidated company, of the following property: One hundred miles of canal, with two vast reservoirs at water-sources, and some five or six receiving and distributing reservoirs; six miles in length of the great main gravel channel; five miles of deep tunnels, together with several miles of iron pipe and sluices, under-currents, &c., and large quantities of mining tools, with at least two large mills. It has taken the Bloomfield company eight years to bring its works to their present condition, and it will be at least two years more before the system is entirely complete.

In the vicinity of North San Juan is the extensive property of the American Mining Company, described at length in my report for 1870, (rendered March, 1871,) pages 74–76. This has been one of the most successful operations of this class of mining in the State. A recent number of the Nevada Transcript says of this claim:

> These claims were opened in 1853, and, although constantly worked, they have increased in value ever since, additions having been made by the purchase of other claims at a cost varying from ten thousand to a hundred and fifty thousand dollars. The main channel extends a mile to the front of their present works. The company employs about fifty men the year round. Water is low now, and they are running only five nozzles of the largest kind, carrying over 12,000 inches of water. These works furnish an example of what industry, good judgment, and skill can accomplish in bringing to light the vast treasure concealed in these mountains. The present site of these claims is an extensive artificial cañon glittering with bowlders, where once stood a high hill crowned with primeval forests of oak and pine. Under this hill have been blasted out of solid rock tunnels thousands of feet in length, through which the mountain, loosened by powder and pick, and by means of hydraulic pressure, has been sent rolling and foaming into the deep gorge of the Yuba below. Into these sluices are swept, indiscriminately, rocks, sand, and pay-dirt, but the under-currents, an ingeniously contrived saving apparatus, placed in these sluices and at the mouth of the tunnels, allow nothing of value to escape. This company owns good grounds, but there is another secret of success which no one visiting the mine can fail to notice—each one of the shareholders is a working-man.

The Sweetland Creek Mining Company of London possesses one of the most extensive and valuable hydraulic claims in California.

The annual report of the superintendent of the company indicates that from recent surveys the rich channel of ground will last at least double the time anticipated. After a run of 52 days a clean up of $25,000 was made, of which $14,000 was net profit, a satisfactory result for the first run of the season. During the year the new tunnel was run 355 feet, and a shaft 75 feet deep raised to the surface. The tunnel sluices have been extended 664 feet, making the whole length of tunnel sluices at 2,724 feet, and 280 feet of outside extension added to this makes the whole length of sluices 2,694 feet. The aggregate cost of tunnel, two shafts, sluices, &c., has been $32,799. During the year the creek returned gross $16,262, at a total cost of $8,200; net profits $8,062. That portion of the creek above the slip tunnel, of about 1,600 feet in length, has been a receptacle for tailings for ten or fifteen years. The basin is formed by a rock barrier or shoal of 800 feet length in the bed of the creek. This bar at its upper end coincides with the slip. This obstruction was partially remedied by the slip-tunnel, and the tailings above materially lowered, and the grade from the new tunnel-sluice much improved, but still found insufficient for the heavier *débris*. In order to remedy finally this defect of outlet to the new tunnel, and to form a casement or conduit for the economical working of the tailings above, (an opportunity offering during the absence of water for the last four months of the year,) they have driven a cut of 800 feet length by 7 feet deep and 5 feet in width. The cost of such cut, confined to giant-powder and labor, was $5,500, the whole of which cost was taken from the creek during the construction of the cut, and most of the amount from the immediate track of cut. The cut will have yet to be extended as the creek is worked, but with lessening depth and cost as the creek deepens above the bar. The outlet from the new tunnel is now ample and works admirably, the rough bottom and sides of the cut forming a disintegrator for liberating and brightening the gold before it comes in contact with the mercury in the sluices and undercurrents below.

The Blue Tent Consolidated Hydraulic Mining Company of Nevada County is an English corporation, owning 500 acres of mining-ground, with an average depth, from surface to bed-rock, of 450 feet. The outlet for the tailings is the South Yuba River, which gives them a fall of 500 feet below bed-rock, thus affording ample fall, which is of the greatest importance to the successful working of hydraulic mines. This company is now engaged in prosecuting two important and expensive enterprises for the better development of its claims, and also in supplying them with free water. One of these is a bed-rock tunnel, running into the hill, which, when completed, will be 400 feet long. The tunnel is 6 by 7 feet, and 120 feet remains to be run, which it is expected will take till February 1st. As soon as completed a shaft will be raised to the surface, and the ground worked through the tunnel. The other project consists in the construction of a ditch to the claims of the company, from a point about half a mile above Culbertson's bridge, in a narrow gorge on the South Yuba River, where it has located a water-right. A substantial dam has been built with heavy logs 20 inches square, bolted to the bed-rock with 2-inch iron bolts, and filled in above with large bowlders, timbers, &c. The dam is 31½ feet long and 3 feet high. A bed-rock channel is being now blasted through Rocky Bar, through which the water will flow from the dam. A flume commences at the end of Rocky Bar, which will be 4 by 6 feet, and about four miles long. From the lower end of the flume to Blue Tent, a distance of twenty-three and a half miles, the water will run in a ditch, with the exception of a few short places that require fluming. Two tunnels will have to be run, one of 1,000 feet in length, and the other 300. The ditch will have a capacity of 5,000 inches of water—miner's measure—and will have a fall of 11.20 feet to the mile. The total distance of the ditch from the dam to the company's claims at Blue Tent will be twenty-seven and a half miles. The estimated cost of the work, when completed, will be $100,000. The ground owned by this company embraces the claims formerly known as the Darst, Smith & Cooper, Enterprise, Empire, Bond & Kilham, Gopher, South Yuba, Blue Lead, and other smaller claims, embracing all the principal mining-ground in Blue Tent district, except the Central and Sailor Flat property. From the records of these companies it appears that the ground now embraced in the property of the Blue Tent Company has yielded $770,000. Mr. H. S. Bradley, United States deputy mineral surveyor, measured the ground and ascertained that 5,101,150 cubic yards had been washed from it.

Professor Silliman, in his report to the present owners, estimates that the $770,000 worth of gold obtained from the several claims was derived from washing down 5,101,150 cubic yards of gravel, much the larger part of which was top gravel, from 300 to 350 feet above bed-rock. He says further:

> The estimated value of such gravel is placed at 10 cents per cubic yard. The general average by actual measurement gives 15 cents per cubic yard. The data necessary

> to calculate the probable time which the mass of gravel in this property will last, if worked at a certain rate, were arrived at thus: 5,101,150 cubic yards worked, divided by 2⅓, equals 2,186,207 cubic yards, the quantity for one year's dividends on the company's basis; therefore, 415,866,359 cubic yards of reserves, divided by the above quantity, for one year, will give one hundred and ninety years as the length of time which these reserves will last, if the rate of consumption estimated is maintained. But it will be remembered that as the washings approach the bed-rock the gold product increases, and the rate of washing becomes slower, because the lower gravel is harder, so that the actual time required to wash off the whole mass of gravel will probably exceed by several years the period now calculated.
>
> Mr. G. D. McLean, superintendent of the Sweetland Creek, states that the gold-bearing gravel attains a maximum thickness of 1,000 feet. The 490 acres comprising the area are almost entirely overlaid with alluvium, but in order to compensate for the exhausted pits, and any points where the survey may overlap the rim-rock, we will lessen the area to 400 acres, as a basis of calculation, and the average depth to 225 feet. In 400 acres of gravel, 225 feet deep, there are 145,200,000 cubic yards, including all of the richer under-strata estimated at only 15 cents per cubic yard, which, at the average obtained from the 5,158,150 cubic yards exhausted, gives $21,780,000 gross as the returnable contents of the property. Suppose three monitors, under a pressure of 300 feet, to discharge each 1,000 inches of water, and to wash jointly 9,000 cubic yards per day of twenty-four hours, and to operate continuously for ten months, over fifty-three years would be required to exhaust the property, whereas if the additional depth of the placer was estimated at 10 cents per cubic yard, the amount returnable would be over $33,000,000, and ninety-four years or more would be required for the displacement. The expense usually attending hydraulic operations is from one-fourth to one-third of the gross returns—the water belonging to the mine.

In the country between Greenhorn Creek and Bear River the following companies have been actively at work: Jacobs & Sargent, at Quaker Hill; Rose & Duryea, at Buckeye Hill and Chalk Bluff; the Birdseye Company, at You Bet, and the Little York. They run from four to six streams and consume about 2,000 inches of water, each under a pressure ranging from 150 to 250 feet each. They usually make two weeks' run, clearing up from $1,200 to $2,000 to each pipe, with the exception of the Little York Company, which owns three ditches having capacity to carry 1,000 inches each. These parties obtain nearly all their water from the South Yuba Company, which owns the most extensive system of canals and the best water franchise in the State. Water is sold at the low price of 12½ cents per inch for twenty-four hours. Of the ten or a dozen cement-mills operating about here a few years ago not more than two or three are now running; the manner in which the cemented gravel is now broken up with powder and the powerful streams brought to play upon it, aided by the present more efficient system of undercurrents and dumps, enabling the miner to extract the gold from this material pretty effectually without recourse to crushing, which, besides being expensive, was a very slow and tedious method for disposing of it.

Dr. Henry Degroot, in his correspondence to the Mining and Scientific Press, of San Francisco, says of this region:

> As regards hydraulic gravel, there is enough along the ridges formed by Bear River, Steep Hollow, Greenhorn and their branches to profitably employ the water flowing through half the ditches in the State. There are here thousands of acres of deep gold-bearing banks, some of them just sufficiently prospected to demonstrate their value, with here and there a small patch washed off or being actively worked, the greater portion remaining wholly untouched. Under these ridges run in every direction sections of the old buried rivers, carrying in the lowest part of their channels the characteristic blue gravel.
>
> The idea of there being but one dead river creating a single blue lead, is, of course, now exploded; experience having shown that these ancient channels are very numerous in this region of country, and that each one has created its own "blue lead"—this being the color of the gravel wherever it lay sufficiently low to be protected from the influences of the air and the atmospheric water, which, by decomposing the iron pyrites present, have tinged the upper strata gravel with a rusty hue. Doubtless there was one main river that, with many meanderings, flowing generally north and south, passed in this vicinity through Quaker Hill, Red Dog, under Chalk Bluff, having here made a sharp curve to the east, after which, doubling on itself, it swept round to the

> southwest, and passing You Bet, bore off to the southeast through Little York till it reached Dutch Flat, where, making another deflection to the southwest, it held on in that direction through Gold Run, Low Hill, and Forest Hill to Todd's Valley, where it disappears, having been swept away by the Middle Fork of the American River. This central trunk had many branches, vestiges of which are found coming in on the east at Berrington Hill, Mount Oro, Buckeye Hill, Chalk Bluff, Little York, and under or along all the other ridges between Bear River, Steep Hollow, Greenhorn and their tributaries, enriching the diggings at Elmore, Liberty, Lowell, and Remington Hills, and also at Stranahan's, the Cascades, Red Diamond, and many other old camps along these several divides.

For the following information concerning the Liberty Hill placer mine, I am indebted to Mr. A. J. Doolittle, one of the owners: This claim was purchased by its present proprietors about two years ago. They are now developing it, their aggregate expenditure hitherto having been $76,000. It comprises 240 acres. The gravel is 40 to 100 feet deep, cemented at bottom and hard to work, but profitable. A bed-rock tunnel 1,600 feet long is contemplated. They have now a ditch nine miles to Bear River, carrying 800 to 1,600 inches; a reservoir at the head and a dam in the South Yuba, to which it is intended to extend the ditch—a distance of five miles. At Liberty Hill they have two reservoirs; one covering 5.53 acres, (capacity, 1,180 inches for ten hours, through 3,000 feet of 15-inch pipe, under 270 feet pressure,) and the other covering two acres and supplying 2,000 feet of 11-inch pipe, under a head of 150 feet. They also have some other small ditches.

The Little York Gold-Washing and Water Company adjoins the foregoing. It is an English concern. Its ditches are three in number and extend to Little York. Northward from this point to Lowell Hill, there is a large area of gravel, covered with lava and volcanic cement. At Lowell Hill are the Swamp Angel and other valuable and extensive drifting-claims. At Remington Hill, Democrat Hill, Excelsior Hill, and Bald Eagle there are drifting-claims, and hydraulic workings when this system is not prevented by overlying cemented lava. The whole ridge is the best supplied with water in the county. The aggregate capacity of the Yuba, Little York, and Liberty Hill ditches is about 3,500 inches, which is doubled for the ten-hour shift by means of reservoirs. Water costs 10 cents per inch for ten hours. The season varies from four to eight months. Miners' wages, $3 per day.

The condition of quartz-mining in the vicinity of Grass Valley and Nevada City seems to have been one of unusual prosperity during the year 1873. The leading mines of Grass Valley have kept up their gold-product, as will be seen by reference to the interesting reports of the Eureka and Idaho, while in Nevada district important improvement is shown in the Providence, Nevada, Murchie, and other mines. An exhibit of the condition of the leading mines of these districts is shown by the carefully-prepared returns of Mr. F. J. Beckett, of Grass Valley. The Grass Valley Union of December 23 gives a review of the present condition of mines in that district, which I have condensed as follows:

> The prospecting business is retarded by the fact that a large number of the ledges here are located and are held by owners who are waiting for something to turn up. No man wants to work and find gold on another man's ledge. After the 10th of next June these locations will have to be worked, or they will be liable to a relocation. There are many claims in this district which ought to be worked or jumped, and they must be after the date we have named.
>
> The underground condition of the Idaho mine remains unchanged, a large ledge of rich pay-ore constantly presenting itself to the miners.
>
> The Eureka kept 15 stamps running during the month, and with them, in four weeks, or twenty-four days, took out about $25,000. There are no changes in the lower portions of the mine.
>
> The run of the Empire for the month of November gave about $14,000, which is not

as large as the yield for the month previous. Still, this $14,000 yield gives a good profit. The underground appearances have improved considerably of late.

The shaft of the Magenta is now down 208 feet. The west drift is in 250 and the east drift 70 feet. All the openings are in good ore with a well-defined ledge. In a few days a second level will be started, arrangements for which are now being made in the shaft. Ground was first broken at the Magenta on the 23d of last August. The Orleans Mill is now crushing Magenta ore. At New York Hill work has gone on steadily. The main tunnel has been run about 150 feet, and there are indications of approaching the ledge. The ore taken from the old tunnel is being hauled to the mill for crushing. Work is being pushed in the upper tunnel and a large amount of first-class ore is being taken out. Free gold appears plenty in the rock, which is also rich in sulphurets. The ore costs $2 per load to take it out, and the hauling and crushing $4. Even low-grade ore will yield a profit at that rate. The fact of no machinery being needed for working the mine lessens the expense of working very materially.

The Ben Franklin is again being worked. Great profits were made years ago out of this mine, and there is no reason to suppose that the pay-ore is exhausted. A tunnel is being run in on the ledge, and is now in a distance of 175 feet.

The North Star continues work in the new shaft. It yielded about $14,000 last month, all from the new works. The old mine shows no improvement.

The Slate Ledge, better known as Perrin's, is opening the fifth level, the ledge on which the posts set more than pay for the opening of the level. To show the quality of the rock we mention that a quantity of rock which cost $900 to mine and mill paid about $5,000 in gold.

On the Greenhorn the depth of the shaft is 496 feet. On the 460-foot level, drifts have been run north and south. The ledge in the drifts is 2½ or 3 feet thick. The rock is now being crushed to test its value.

The Pittsburgh Mine [this is not the Pittsburgh of Nevada City, an extensive mine, described at length in former reports.—R. W. R.] is located near Deadman's Flat, some four or five miles southwest of Grass Valley. It is about a half mile north of the Seven-Thirty mine. The shaft is down 63 feet, and the last 25 or 30 feet of the shaft is through very fine ore. This mine has sent to the mill and crushed 49 tons of ore, that yielded about $50 per ton, or $2,450. None of the owners have had to pay a cent for working the mine, and have divided between $200 and $300 of profits between them. The ledge is between 2½ and 3 feet in thickness.

The Kentucky five-stamp mill started on Monday last to crush the rich ore of the Kentucky mine. The lowest depth of the mine is 235 feet, and drifts have been run east and west a distance of about 50 feet each. No stoping has yet been done. About 300 tons of ore are on the dump-pile waiting to be crushed. This was taken out of the shafts and drifts.

The Massachusetts Hill, Rocky Bar, Scadden's Flat, Stockbridge and other mines in the Massachusetts Hill neighborhood, are still idle, as are also the Wisconsin, Harterey, Allison Ranch, Cambridge, Howard Hill, East Eureka, and other mines.

The Nevada City Transcript has an extended notice of the Gold Tunnel mine and mill, on Deer Creek.

An incline 500 feet has been sunk, from which a tunnel 800 feet has been driven on the ledge. A drain-tunnel extends from the creek to the incline, which is 600 feet long, and connects with the shaft 245 feet from the bottom. The air had become so close in the mine that, notwithstanding nearly 2,000 feet of air-pipe traverse the drifts and tunnels in every direction, it has become necessary to construct an air-chute from the lower end to connect with the end of the drain-tunnel, which is 245 feet above the bottom. This work has been in progress several months, and the rock being excessively hard, the headway made has been slow. The mill is situated about 60 feet below the hoisting works, and the rock from the dump-pile is sent down to the battery by means of a long trough or chute, reaching from the hoisting works to the mill, at an angle of about 45 degrees. The mill is arranged for twenty stamps, but at present ten only are put up. Two hundred yards above the mill, a dam is in course of completion across Deer Creek. It is 80 feet long, 12 wide, and from the lowest part of the creek is 15 feet high. It is built of heavy logs, spiked together, the cribs being filled with rocks and gravel. The creek being flat at this point, the water will be backed up a long distance. A flume connects with the top of the dam which conveys the water to the huge wheel at the mill.

The Providence mine, situated on Deer Creek, about a mile from town, is becoming celebrated, not only for the immense size of the ledge, but also the richness of the rock. The Providence was purchased about two years ago by several private parties for the sum of $60,000, and $48,000 more was expended in sinking new levels, developing the mine,

purchasing new machinery, &c., making a total of $108,000, before the rock began to pay. Within the past few months the mine has increased in value, owing to the richness of the quartz and the mammoth size of the ledge, which is reported to be 40 feet thick.

The Wyoming mine, near Nevada City, was located in 1851. Since active operations were commenced in the mine it has at various times yielded a good deal of ore to its owners. An incline has been sunk a distance of 60 feet on a fine ledge of gold-bearing quartz, which averages two feet in width. Last October the property was increased by the purchase of the Ural or Richards mine, which runs parallel with the Wyoming, and has been heretofore worked through a tunnel running on the ledge, 1,300 feet in length. From the face of this tunnel a cross-cut is being run to cut or intersect the Wyoming ledge. This accomplished, the Wyoming will furnish a large ore supply. At the mouth of this tunnel is a mill, purchased from the Ural Company, which has recently been put in good condition by the Wyoming Company, and is now, with fair profit, crushing ore obtained from an intermediate mine. Fine water supplies the power for running the mill, and can be had in abundance the whole year round. It is the intention of the company to run tunnels to intersect an incline to be sunk next spring. When this intersection occurs, the mine will be opened over 1,000 feet in length and to a depth of between 400 and 500 feet. The Wyoming possesses facilities for taking out and crushing a large quantity of ore at a cheap rate. Nevada County has between forty and fifty mills; but no returns have been received from other districts than Grass Valley and Nevada.

Mr. William Watt, superintendent of the Eureka Gold Mining Company, presents the following report for the year ending September 30, 1873:

We have driven 1,556 feet of drifts, 714 feet of cross-cuts, and sunk 99 feet of winze.

We have hoisted 7,820 tons of quartz, and crushed 7,852½ tons in 305 running days, as follows: Eighty-eight days with 15 stamps, and 217 days with 10 stamps, averaging 2¼ tons per day to each stamp

We have concentrated 86¾ tons of sulphurets, and worked 54¾ tons, and have now on hand 32 tons, which I value at $3,500.

The amount of quartz extracted during the past year from the various levels has been as follows:

	Tons.
From the fourth level	95
From the fifth level	268
From the sixth level	1,444
From the intermediate level	6,013
Making a total of	7,820

There are upward of 5,000 tons of ore in sight, which will pay well on the average.

The expense of extracting the ore is unusually large, owing to the inconvenience of getting to it, a large amount of it having to be handled twice, and the smallness of the ledge during the first half of the year, also the very hard nature of the ground requiring the strongest blasting agents to make any headway. The amount paid for dead work is also large; but, believing the company wished to have the mine fully explored we have been running drifts and cross-cuts, wherever there was a reasonable chance of striking pay-ore; and while I regret not being able to report a more favorable result, I hope for better luck before they are terminated. We have struck nothing very encouraging in either the Mobile or Roannaise; in the former we are running a drift east from the cross-cut, which shows bunches of quartz, good walls, and a good opening between them; in the latter we are sinking a shaft on the ledge, which is two feet wide, but as the shaft is down only sixteen feet, I cannot determine the quality or extent of the ore. Regarding the future prospects of the mine, I can form no decided opinion, as the solution of the question lies deeper than we have been; although, in the eighth level, the walls are good and regular, and four feet apart, but the ledge is small and very poor. The mill, hoisting and pumping machinery, are all in good order.

The Secretary's report gives the following financial statement:

Receipts:	
By cash account, October 1, 1872	$56,654 54
By bullion account	486,854 04
By construction account	95 00
By sulphuret reduction works	2,933 07
By milling account	413 50
By wood ranch	2,013 44
By wood account	13,879 97
By premiums and discounts	1,225 34
By McDougal works	1,004 81
By interest	5,430 13
	570,503 84

Disbursements:	
To dividends	$260,000 00
To mining account	102,591 02
To mining account, prospecting	38,208 50
To milling account	21,690 13
To sulphuret reduction works	2,709 07
To Roannaise mine	1,509 00
To Mobile mine	4,310 25
To wood account	14,580 37
To sulphuret concentration	1,723 59
To McDougal works	388 00
To wood ranch	2,009 75
To general expenses	5,261 84
To bullion expenses	1,812 42
To discount account	53 65
To cash account, September 30, 1873	113,656 25
	570,503 84

Available assets.

On hand, September 30, 1873:		
Cash balance	$113,656 25	
32 tons of sulphurets, estimated value	3,500 00	
250 tons of ore broke in mine, and 247½ tons of ore on surface = 497½ tons, at $12.71 per ton, average cost of mining and hoisting	6,323 22	
1,431⅜ cords of wood	6,084 94	
Supplies at mill	500 00	
Supplies at mine	1,500 00	
Wood ranch, balance of account	196 31	
		131,760 72
Real estate:		
Mill, estimated value	$40,000 00	
Mine improvements and buildings, estimated	30,000 00	
McDougal works, estimated	4,000 00	
Wood ranch, 160 acres	1,500 00	
		75,500 00
Total		207,260 72

Liabilities none.

Mine statement.

	Tons.
October 1, 1872—Ore on surface	280
Ore hoisted during the year	7,820
	8,100
September 30, 1873—Ore on surface	247½
Worked at the company's mill during the year	7,852½

		Tons.
September 30, 1873—Ore on surface		247½
Ore broke in mine		250
Ore reduced during the year		7,852½
		8,350
October 1, 1872.—Ore on surface	280	
Ore broke in mine	200	
		480
Ore mined during the year		7,870

Sulphuret statement.

	Tons.
October 1, 1872—No. of tons on hand	30
No. of tons concentrated during the year	86¾
	116¾
September 30, 1873—No. of tons on hand	32
No. of tons worked during the year at company's reduction works for own account	84¾
No. of tons worked during the year for outside parties	42¾
Total No. of tons worked	127½

Ore statement.

7,852½ tons of ore, worked by mill process, yielded		$480,025 56
Also sulphurets as follows:		
84¾ tons worked by chlorination yielded	$6,828 48	
Less 30 tons on hand October 1, 1872—estimated value	3,900 00	
	2,928 48	
Add 32 tons on hand, September 30, 1873—estimated value	3,500 00	
		6,428 48
Add results of McDougal works		1,004 81
		487,458 85

Or, an average of $61.13 per ton.
Average yield of sulphurets, $80.57 per ton.

Bullion statement.

As reduced by mill process:
Average fineness, .849—equal to $17.54 95-100 per ounce.
As reduced by chlorination process:
Average fineness, .958—equal to $19.81 11-100 per ounce.
Returns from McDougal works:
Average fineness, .766—equal to $15.84 87-100 per ounce.

Return of bullion:

27,352.66 ounces, at $17.54 95-100	$480,025 56	
344.68 ounces, at $19.81 11-100	6,828 48	
63.40 ounces, at $15.84 87-100	1,004 81	
27,760.74 ounces		$487,858 85

		Ounces.
Weight of bullion before assaying		27,771 40
Weight of bullion after assaying:		
Face of bars	27,760 74	
Assay chips and grains	3 20	
Loss	7 46	
Total		27,771 40

Cost of mining.

Supplies on hand October 1, 1872	$1,000 00	
Paid for sundry supplies and labor during the year	102,591 02	$103.591 02

Deduct:		
Supplies on hand September 30, 1873	$1,500 00	
Cost of working sulphurets not belonging to ordinary mining expenses, and included in the above	2,044 82	
		$3,544 82
Cost of mining 7,870 tons		100,046 20

Or, an average cost, of $12.71 per ton.

Cost of milling.

Supplies on hand October 1, 1872	$450 00	
Paid for sundry supplies and labor during the year	21,690 13	
		$22,140 13
Deduct:		
Supplies on hand September 30, 1873	500 00	
For custom-work done and supplies sold	413 50	
		913 50
Cost of milling 7,852¼ tons		21,226 63

Or, an average of $2.70 per ton.

Cost of concentrating sulphurets.

Number of tons concentrated during the year	86¾
Cost of concentrating	$1,723 59

Or an average of $19.87 per ton.

Cost of reducing sulphurets.

Number of tons worked during the year for own account	84½
Number of tons worked during the year for outside parties	42¾
Total	127¼
Cost of reducing:	
Supplies on hand October 1, 1872	$224 00
Amounts paid as per ledger account	2,709 07
Total	2,933 07

Or an average of $23 per ton.

Statement of profits for the year ending September 30, 1873.

Receipts:		
From bullion	$486,854 04	
Amount of sulphurets belonging to last year	3,900 00	
		$482,954 04
From sulphurets on hand		3,500 00
From other receipts		7,730 82
		494,184 86
Cost of same:		
Supplies on hand, October 1, 1872	$6,250 37	
Paid for supplies and labor during the year (including $44,027.75 paid for prospecting or dead work	170,508 89	
Paid all other expenses	7,074 26	
	183,833 52	
Off for supplies on hand, September 30, 1873	8,281 25	
		175,552 27
Net profits		318,632 59

Distribution of profits:

Paid dividends, $13 per share			$260,000 00	
On hand, October 1, 1872:				
Balance cash		$60,554 54		
Balance supplies		6,250 37		
		66,804 91		
On hand, September 30, 1873:				
Balance cash	$117,156 25			
Balance supplies	8,281 25			
		125,437 50		
Amount of former balance of cash and supplies increased during the year			58,632 59	
				$318,632 59

Statement showing the receipts and disbursements of the company from the date of its going into operation, October 1, 1865, to date.

Receipts:			
By bullion taken out		$4,071,597 89	
By other receipts		27,875 32	
			$4,099,473 21
Disbursements:			
To sundry titles. To paid on the purchase of mine. For Whiting ground or square location. Purchase of Mobile and Roannaise mines, and perfecting titles		$301,906 50	
To construction		141,844 71	
To dividends		1,974,000 00	
To mining, milling, and all other expenses		1,556,284 50	
		3,974,035 71	
On hand, September 30, 1873:			
Balance of cash	$117,156 25		
Balance of supplies	8,281 25		
		125,437 50	
			$4,099,473 21

Statement of profits from October 1, 1865, to October 1, 1873.

Receipts:			
From bullion		$4,071,597 89	
From other receipts		27,875 32	
			$4,099,473 21
Cost of same:			
Paid for mining, milling, and all other expenses			1,556,284 50
Net profits			2,543,188 71
Distribution of profits:			
Paid for sundry titles		$301,906 50	
Paid for construction		141,844 71	
Paid for dividends		1,974,000 00	
		2,417,751 21	
Balance of cash	$117,156 25		
Balance of supplies	8,281 25		
		125,437 50	
			$2,543,188 71

The Idaho mine of Grass Valley, which ranks as the leading quartz mine of California, and is one of the most productive gold-mines in the world, is situated immediately east of and adjoining the Eureka. These two mines have paid since their incorporation an aggregate of $3,258,950 in dividends. The Idaho has paid regular monthly dividends for several years, having disbursed to stockholders some $1,284,950, of which

$682,000 was paid this year. The entire receipts of the mine have been $2,311,437, of which $1,010,612 was the product of 1873.

The secretary's report, together with the report of the president, shows in detail the operations of the fiscal year ending December 1, 1873. That the operations have been successful appears in the fact that $682,000 have been divided among stockholders after expenses were paid.

The old shaft has been abandoned, and the new one is completed to the 700-foot level, 35 feet toward the 800-foot level not being yet of the full size. The 400-foot east level is in 765 feet from the shaft, of which 368 feet are through pay-ground, and the last 397 feet are through barren ground, with a small stringer most of the distance. The 600-foot east backs are worked up to the 500-foot level, 210 feet from the shaft, thus enabling them to form that level in worked-out ground for that distance, and the quartz is all standing between the 400-foot level and the 500-foot level.

During the year the company has worked 27,624¾ tons of rock, of which 8,605½ tons came from the 400-foot level; 11,481½ from the 600-foot level; 6,937¾ from the 700-foot level. This gave a gross yield of—

56,210.80 ounces bullion	$979, 959 39
212½ tons of sulphurets	28, 318 00
25 tons on hand, estimated	3, 000 00
Specimens	364 50
Tailings	12, 950 00
Total	1, 024, 591 89

Giving an average of $37.91½ per ton. During the year the company ran 1,012 feet of drift and completed 329 feet of shaft.

The superintendent gives the following as the receipts and disbursements:

Disbursements:

Mill and mining	$232, 847 44
Saving sulphurets	2, 908 00
Prospecting in 400	3, 124 00
New shaft	22, 792 00
Blacksmith-shop	1, 263 49
Construction account	8, 096 57
Water-works	3, 602 46
Extension of ditch to Scott Flat	8, 738 84
General account	41, 612 00
Total	324, 984 80

Receipts:

Cash on hand from last settlement	$6, 669 70
Proceeds from bullion	979, 950 39
Sale of sulphurets	23, 119 00
Sale of specimens	364 50
Percentage from tailings	5, 265 83
Total	1, 008 708 12

Pan rent	$907 00
Water	486 00
Old material	511 08
Total	1,904 08

Total receipts	$1,017,281 90
Total expenditure, including dividends	1,006,984 80
Cash on hand	10,297 10

The milling and mining account in the disbursements is interesting. It is as follows:

Surface labor	$41,554 59
Underground labor	119,036 24
Wood, poles, and lagging	23,314 21
Powder and fuse	3,795 00
Hardware	10,233 18
Lumber	3,091 77
Candles and oil	4,580 13
Coal	2,005 37
Quicksilver	2,941 41
Foundery	10,046 60
Drill-steel	1,106 36
Water	1,463 50
Superintendent's salary	6,000 00
Sundries	3,679 08
Total	232,847 44

Average cost of milling and mining, $8.61⅓ per ton.

Saving 237½ tons of sulphurets	$2,908 00
Prospecting 397 feet in barren ground in 400 level	3,124 00

In sinking the new shaft the sum of $14,046 was expended for underground labor, and $3,329 for surface labor. The labor on the water-works cost $1,147, and the labor on the extension of the ditch to Scott Flat was at an expense of $5,828.

The secretary's report shows the receipts and disbursements, not only for the year, but for each fiscal year, beginning in 1869. The total receipts for the year ending December 1, 1873, were $1,010,612.20, to which the balance on hand December 2, 1873, being added, gives a total of $1,017,281.90.

The total expenses for the year, including the dividends, were $1,006,984.80, and balance in the Treasury is $10,297.10.

The dividends for the year amount to 220 per cent. on the capital stock, and aggregate $682,000. The dividends of January, February, and March were 15 per cent., or $46,500 each. Those of April, May, and June were 20 per cent., or $62,000; that of July was 25 per cent., or $77,500; those of August, September, and October were 20 per cent., or $62,000; and those of November and December were 15 per cent., or $46,500.

The aggregate receipts and expenditures of the company for the past five fiscal years are interesting. The receipts from all sources were as follows:

1869	$306,038 75
1870	183,450 23
1871	407,301 16
1872	404,035 52
1873	1,010,612 20
Receipts for five years	2,311,437 86

Dividends have been as follows:

1869, 11 dividends, or 55 per cent	$170,500 00
1870, 8 dividends, or 12 per cent	37,200 00
1871, 12 dividends, or 75 per cent	232,500 00
1872, 11 dividends, or 52½ per cent	162,750 00
1873, 12 dividends, or 220 per cent	682,000 00
Total	1,284,950 00

This shows that 53 dividends have been paid in five years, aggregating 414½ per cent. of capital stock, and amounting to the sum of $1,284,950.

Mr. Edward Coleman, president and superintendent of the Idaho Company, says in his annual report to the stockholders:

In reviewing our operations for the past year, I feel it is unnecessary to say that it has been a very successful one. This fact has been very forcibly brought to your minds from month to month in the shape of regular dividends, amounting in the aggregate to the sum of $682,000 for the year.

Soon after our last annual meeting it came to the notice of your trustees that our interests might come in conflict with that of the Schofield Mining Company's location, and it was thought advisable by your board to anticipate any trouble in that direction. We accordingly entered into negotiations with certain parties, and the result was the purchase of all their rights for the sum of $25,000. This, it is believed, perfects our title to all our claim, beyond dispute.

The mine continues to look well. The developments in depth would seem to indicate that we may reasonably expect the mine to last many years, with good returns.

The new shaft is completed to the 700 level, and it is down 35 feet toward the 800 level, but not the full size. The old shaft is abandoned, and all the work is being done through the new one. The 400 east level is in 765 feet from the shaft, of which 368 feet is through pay-ground, and the last 397 feet is through barren ground, with a small stringer most of the distance. The 600 east backs are worked up to the 500 level, 210 feet from the shaft, thus enabling us to form that level in worked-out ground for that distance, and the quartz is all standing between the 400 level and 500 level.

The 600 east level is in 595½ feet from the shaft; 473½ feet from the shaft the ledge split; we followed the south branch 122 feet; it then gave out. We have now followed the north branch about 30 feet from the split; the ledge seems very unsettled, but from indications in the 400 level it ought to extend 250 feet farther; still it is not reliable. The 600 west is about all worked out. The 700 west is in 428 feet from the shaft, and the backs are about 250 feet in length. The drifts and backs produce good average rock. The 700 east drift is in 195 feet from the shaft, and the backs are 192 feet in length. This drift and backs also produce average rock. During the year we have worked 27,624¾ tons of rock, of which 8,605½ tons came from the 400 level; 11,481½ from the 600 level; 6,937¾ from the 700 level. This gave a gross yield of—

56,210.80 ounces bullion	$979,959 39
212½ tons of sulphurets	28,318 00
25 tons on hand (estimated)	3,000 00
Specimens	364 50
Tailings	12,950 00
Total	1,024,591 89

Giving an average of 39.91½ per ton.

During the year we have run 1,012 feet of drift, and completed 329 feet of shaft. The machinery is all in good working order, and I know nothing to occasion any large expenditure of money, separate from the legitimate workings of the mine.

The following is the statement of the North Star Mine, Grass Valley, evada County:

Receipts:	
Procured from bullion	$131,932 55
Sulphurets	17,133 95
Other sources	3,271 01
	152,337 51
Expenses:	
Mining, (including labor supplies)	$95,733 25
Milling expenses, labor supplies	33,977 07
Cost of working sulphurets	5,486 84
Miscellaneous expenses	12,741 57
	147,938 73
Improvements on mine and mill	$4,222 82

During the year, 7,391½ tons ore were crushed, and $285\frac{285}{1000}$ tons of sulphurets were concentrated and treated by chlorination.

Statement showing operations of leading mines of Grass Valley district, Nevada County, Cal., for year 1873.

Mines.	Owners.	Total No. tons raised.	Total No. tons worked.	Average yield per ton.	Total bullion product.	No. stamps employed.	Cost mining per ton.	Cost milling per ton.	Company or custom mill.	Miner's wages per day.	No. miners employed.	Remarks.
Idaho............	Idaho Quartz Company	27,624¾	27,624¾	$37 91¼	$1,024,591	35	....	......	Company's	$3 00	148	Cost of mining and milling, $8.61 per ton.
Eureka	Eureka Gold Mining Company.	7,820	7,852½	62 00	486,854	30	$12 71	$1 84	....do	3 00	115	Sixteen men in mill and concentration works.
Empire	Empire Gold Mining Company	8,000	8,000	30 00	240,000	20	12 50	1 50	....do	3 00	80	Eleven men in mill.
North Star.......	North Star Gold Mining Company.	7,500	7,391	20 00	150,000	24	11 00	3 00	....do	3 00	60 to 80	New shaft, sunk 1,400 feet east of old works; now 400 feet deep.
New York Hill ..	A. Delano and others........	....	....	45 00	....	......	2 00	4 00	....	1 75	6	Work suspended since October 1, 1873; now resumed by tunnel, permitting the extraction with profit of low-grade ore.
Kentucky.........	Kentucky Gold Mining Company.	500	300	17 00	5,000	5	....	1 75	....	......	....	

NOTE.—The Idaho was reported by Mr. Edward Coleman, superintendent; the Eureka and Kentucky by Mr. J. F. Beckett; and the New York Hill by Mr. A. Delano.

Statement showing operations of leading mines in vicinity of Nevada City, Nevada County, Cal., for year 1873, reported by C. H. Mead and John Berry.

Providence	Walrath, Smith, and others ..	4,500	4,500	$10 00	$45,000	10 at Co. mill.	$2 75	$1 25	Both......	$3 00	22	This company developed a ledge varying from 40 to 50 feet in width on the 400-foot level.
Nevada	I. S. Van Winkle & Co	4,000	4,000	5 50	22,000	8	3 50	1 00	Company.	3 00	8	

List of producing mines in the vicinity of Nevada City, Nevada County, Cal., reported by C. H. Mead and John Berry.

Name.	Owner.	Location.	Course.	Dip.	Dimensions.		Development.		Country-rock.	Vein-matter.	Average value, per ton.	Per cent. sulphurets, per ton.	No. of tons extracted and milled during the year.
					Length.	Thickness.	Depth of main shaft.	Total length of drifts.					
					Feet.	*Feet.*	*Feet.*	*Feet.*					
Montana	Montana Company	Willow Valley.	N. E. and S. W.	W.	1,500	1	250	1,100	Granite	Quartz, with sulphurets	$33 00	5	500
Providence	Walrath, Smith, and others	Deer Creek	N. E. and S. W.	E.	3,000	*50	475	220	...do	......do	10 00	5	4,500
Nevada	I. S. Van Winkle & Co	....do	S. E. and N. W.	E.	3,020	2 to 16	225	5,280	...do	......do	5 50	2½	4,000

* The vein is reported to be fifty feet thick on the 400-foot level.

List of producing mines in the Grass Valley district, Nevada County, Cal., reported by A. Delano, Edward Coleman, and J. F. Beckett.

Name.	Owner.	Location.	Course.	Dip.	Dimensions.		Development.		Country-rock.	Vein-matter.	Average value, per ton.	Per cent. sulphurets, per ton.	No. of tons extracted and milled during the year.
					Length.	Thickness.	Depth of main shaft.	Total length of drifts.					
					Feet.	*Feet.*	*Feet.*	*Feet.*					
New York Hill *	A. Delano	Grass Valley	N. W. and S. E.	E.	2,800	1½	700	1,500	Greenstone	Quartz and clay	$45 00	.....	.....
Idaho	Idaho Company	....do	N. 76° 50′ E.	67° S.	1,112	3½	753	3,277	Serpentine foot-wall; metamorphic hanging wall.	Quartz	37 91	1½	37,624
Empire	Empire Company	....do	E. and W.	43° S.	1,800	1½	1,300	7,500	Slate	....do	30 00	1½	8,000
Kentucky	Kentucky Company	One and a half mile north of Grass Valley.	E. and W.	N.	1,300	1 to 4	230	150	......do	....do	17 00	1½	500
North Star	North Star Company	Grass Valley	E. and W.	30° N.	3,000	1 to 2	1,200	†6,000	......do	....do	20 00	3	7,391
Eureka	Eureka Company	....do	E. and W.	68° S.	2,604	3½	1,072	8,000	......do	....do	62 00	1½	7,852

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* This mine was suspended for some years, but finally passed into the hands of the present proprietor, who has commenced opening it by tunnel. A fine ledge has been reached, and is now worked cheaply at large profit. No machinery is needed for hoisting ore to the surface, and all difficulty from water is obviated. It is only just in active operation under the new mode of working. There is no mill on the mine. The sulphurets are worth $150 per ton, after concentration.

† This is a mere guess. The longest drift in this mine is 2,000 feet; and the aggregate length of all the levels may be considerably more than that given in the table.

List of mills in Grass Valley and Nevada districts, Nevada County, California, reported by J. F. Beckett and Edward Coleman.

Name of mill and owner.	Location.	Power.	Horse-power, engine.	Number of stamps.	Weight of stamps.	Number of drops per minute.	Height of drop.	Number and kind of pans.*	Number and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours.	Crushing capacity of mill per 24 hours.	Loss of mercury, lbs. per ton.	Cost of treatment, per ton.	Running-time, months.
					Lbs.		*Inch's*				*Cords*	*Tons.*			
Kentucky	Grass Valley	Steam	12	5	850	70	10	1 Knox	1	$2,000	1½	10	......	$1 75	2
Idaho	do	do	91	35	850	65	10	1 Knox; and Eureka rubber.	Buddle	38,689	7	90	0.09	......	12
North Star	do	do	60	24	1,000	60	8	2 Knox	10 Hendy	......	12	35	......	3 00	......
Eureka	do	do	60	30	850	62	10	do	2 Buddles	40,000	6	67	......	1 84	12
Empire	do	do	60	20	850	65	10	8 Combination	8 Hendy	45,000	11	30	......	1 75	11½
Nevada, J. S. Van Winkle	Deer Creek	Water	......	8	900	80	8	None	Rockers	20,000	......	20	......	1 50	12

NOTE.—The North Star mill ran irregularly during the year. The Eureka mill ran twelve months, but not always at full capacity, with all the stamps. Five new stamps were added in November, 1873, to the Nevada mill; Nevada Company's sulphurets are treated at Maltman's chlorinating works; custom rate, $25 per ton.

YUBA COUNTY.

I am indebted for information concerning the condition and prospects of the hydraulic mines in this county to a correspondent at Smartsville.

As has been stated in former reports, the principal hydraulic mines of this county are located at and near Smartsville. The gravel-deposits are about three miles long, running from Mooney Flat, westerly, between the towns of Smartsville and Sucker Flat, to Timbuctoo.

The following is a list of the tunnels in this locality: Enterprise, 2,600 feet long, in constant use; Blue Point, 2,270 feet long, in constant use; Blue Gravel, 1,700 feet long, in constant use; Blue Gravel, (middle,) 1,400 feet long, abandoned; Blue Gravel, (upper,) 600 feet long, abandoned; Rose's Bar, 1,000 feet long, finished March, 1874; Pactolus, 1,100 feet long, in constant use; Pactolus, (upper,) 300 feet long; Greenhorn, 500 feet long, in constant use; Pittsburgh, 500 feet long, abandoned; Pittsburgh, (lower,) 900 feet long, work, stopped; Michigan, 300 feet long, abandoned; Deer Creek, 500 feet, finished January 1, 1874, and work being pushed as fast as possible.

The water used by the several companies whose tunnels have been enumerated above, as also that used by the Smartsville Consolidated Hydraulic Mining Company, (between Enterprise and Blue Point, working top lead at present,) is mostly supplied by the Excelsior Canal Company, the ditches of which are now delivering an average for the year of over 4,000 inches per day. When the Deer Creek Company's tunnel is finished, furnishing another outlet, the supply will be increased.

During a part of the winter and spring months the Nevada Reservoir Ditch Company supply the Blue Point Gravel Mining Company; in part the Smartsville Consolidated Mining Company. A brief description of the Enterprise Mining Company's operations may be of interest, as it has never been alluded to before, being undeveloped hitherto. This Company owns a large amount of ground, which will average from 200 to 300 feet deep. It started a tunnel about three years ago, and finished it, as at first surveyed, in November, 1873, since which time it has been run 100 feet farther. The first blast will be exploded about the last week in January, 1874, and immediately thereafter 1,000 or 1,200 inches of water will be turned on, and active hydraulic operations begun. The tunnel will average more than 7 feet wide and 9 feet high, and is between 2,600 and 2,700 feet in length. The flume consists of 440 boxes 14 feet long, 4 feet wide, and 3 feet deep, rock-lined throughout on bottom, and block-lined on sides at lower end. The grade is 7 inches to the box except on curves, where it is greater. The amount of dirt to be moved is about 9,000,000 or 10,000,000 cubic yards; and if it will pay one-half the average for the locality, the stockholders will be handsomely repaid. The entire cost to January 1, 1874, will exceed $75,000.

Passing the Smartsville Consolidated Hydraulic Mining Company and Blue Point Gravel Mining Company, which have been diligently at work, and the Union claim, a very narrow strip of ground, we come to the Blue Gravel Mining Company's claim. This mine has made by far the richest returns of all the claims in the county. The lower tunnel having been completed, the first "clean up" was made in July and the second in December, 1873; and the bullion obtained was sufficient to keep up the former reputation of the mine. The gravel in this deepest gutter of the channel is very rich; but the quantity is limited. The Pittsburgh is now idle.

The Rose's Bar Company's ground, lying next west of the Pittsburgh

Company, is 1,800 feet long on the channel. The upper lead is now being worked at a moderate profit, while from shafts sunk in the lower lead the prospects obtained are sufficient to warrant the belief that this claim will soon rank next to the Blue Gravel. This company's deep bed-rock tunnel was in 965 feet on January 1, 1874. When it has been driven to 1,000 feet, an incline will be raised, and washing the rich lower lead will be commenced as soon as possible. For the first 800 feet the rock in this tunnel was very soft, and rapid progress was made; but the next 100 to 150 feet proved to be much harder, and the distance accomplished per month was reduced as low as 12 feet.

The Pactolus is now making its first run through the lower tunnel.

In the Babb claim, formerly celebrated, operations have been suspended temporarily.

Active work is going on in the Greenhorn claim, and the first clean-up, after a long run, will be made in February.

The Deer Creek Company's tunnel, located at the eastern end of the lead, will tap an enormous body of ground, nearly 400 feet thick, at the deepest point.

Mr. Amos Bowman, late of the State geological survey, who has devoted considerable time to the study of the geological features of this locality, and who has also surveyed and measured all the ground for the Excelsior Canal Company, states that the total amount of gravel in place, before mining was commenced, was in round numbers 125,000,000 cubic yards, and that upward of 25,000,000 yards have been moved, leaving nearly 100,000,000 cubic yards yet in place. Mr. Bowman also states that the known yield of the mines exceeds $6,000,000, or say 25 cents per cubic yard, but also estimates that from $2,000,000 to $4,000,000 have been taken from the bars in river and surfaces of ravines in "early days," of which no record was kept.

About forty years will be required to "work out" this locality, running off the gravel at the rate of 8,000 yards per day.

BUTTE COUNTY.

During the present year considerable excitement was created in the vicinity of Oroville by the discovery of rich placer-diggings in ground the auriferous character of which seems to have been overlooked for a long period, and which had come to be considered as agricultural. This discovery was made at this late period in a region which was once the center of an active mining population; but of late years the principal interest has been agriculture and fruit-raising.

About a half mile east of the Feather River, and about two and one-half miles from Oroville, is the scene of the new diggings. A year ago a young man named Kline was led to locate a claim, and prospect, at a point near that named. He, it appears, struck it rich, but kept the matter a profound secret. By some means, however, the success of the boy became known to Mr. Gray, who holds a ranch hard by, and he began a series of explorations upon his own ground, resulting in the discovery of pay-dirt. This was about one month ago. Gray at once offered his land in the region of the mine for sale in small parcels, or for rent. The Chinese, ever on the alert, heard of the new grounds, and were soon on hand to buy and to lease. Gray has been kept busy ever since in making transfers and leases. For 200 feet square of ground he received at first $100, but since then few know what he has sold for. Outside of the Gray ranch hundreds of claims have been located, and scores sold to Chinamen, as "John" is prohibited from locating for himself.

But few whites have been engaged in active work on these claims—almost all the locations having been made with the intention of selling to the Chinese. Two hundred feet is allowed to the man, and one day's work in ten holds the ground. Claims have been sold as high as $10,000 to Chinese companies.

Mr. Atwill, a correspondent of the Sacramento Record, says:

> The region already prospected is about one and a half miles square; not more than one-eighth of this lies within the bounds of any patented ranch. The soil is a sandy loam; the surface of the earth perfectly level. Sinking from 8 to 10 and 12 feet, the prospector strikes a stratum of gravel about 2 feet thick; this yields nothing, but in nearly every instance he finds pay-dirt just beneath it. The dirt has been proven in some cases 8, and in others 10, feet in thickness or depth. Water is obtained by sinking some 12 to 18 feet, and drawn up for work. All the washing is with pan and rocker, in the most primitive style. The gold is fine, scaly, river-gold, and lies closely together. As high as 25 cents to the pan has been taken out, but the average seems to be 6 and 8 cents. No capital is required to work these mines; as now handled, $7 or $8 suffices for a very good prospect. There are plenty of Chinese who will sink the prospect-hole for what they can get out of the bottom.

Instead of working this ground, as in 1849 and 1850, the locators sell to Chinese at prices ranging from $10 to $200 per lot. The purchasers sometimes wash out $1,000 per week, and Oroville and Marysville bankers state that the Chinese ship regularly from this locality an average of $18,000 per week in fine gold.

Mr. W. F. Stewart, a gentleman who has made the geological features of the California mining region a study for years, has recently visited this county, and in a communication to the Mining and Scientific Press of San Francisco says:

> The life and soul of Butte County are the amazingly colossal works which are being carried on in the famous tertiary beds at Cherokee and at Morris Ravine. These great placers, underlying what is known as Table Mountain, extend from Oroville to Dogtown, in the direction north and south, fully twenty miles, and are unquestionably the most extensive placer-gold deposits in the world. The bed-rock of the placer is clay-slate, mingled with talcose slate and hard schistose rocks. Upon the bed are found petrified oak logs, and occasionally bones and teeth of the mastodon, precisely as such vestiges are in the rich gold-drift in Siberia. Mingled with the logs and bones is a concretionary deposit of washed pebbles, containing magnetic iron, sand, olivine, and diamonds. This gravel-bed is the chief matrix of the gold, which is mainly found in fine particles, but is sometimes met with in the form of lumps and nuggets. The gravel-bed ranges from 3 feet to 10 feet in depth, and is really the true pay-dirt. Upon the gravel stratum rests a heavy layer of white quicksand, mingled with iron oxide and tertiary clay. This sand-bed is from 10 to 100 feet in depth, and although it contains a little fine gold, is comparatively barren. The crown and summit of the entire mass is a broad sheet of black basalt, columnar in structure, hard as iron, and with a perpendicular thickness of from 10 to 60 feet. This basaltic cap makes the uneroded summit which has formed the tertiary beds into table mountains. The work which has been done by the Messrs. Hendricks at Morris Ravine, and by the Spring Valley Water Company at Cherokee, is simply herculean. They have brought water through pipes, flumes, and ditches for many leagues, over almost inaccessible mountain-fastnesses; they have demonstrated unheard-of facts in hydrostatics and pneumatics; they are now gnawing away both ends of the great tertiary bed with 6,000 inches of water, and are monthly cleaning up hundreds of thousands of dollars in gold.
>
> At Cherokee Flat, the Spring Valley and Cherokee Mining Companies, which were consolidated early in 1873, have completed their ditch from Butte Creek, crossing the west branch of Feather River, connecting with the former ditch of Smartsville Mining Company. This now furnishes a good supply of water, running two and three 7-inch pipes. The number of pipes will be increased to five during the winter. The company expects to receive $2,000 on an average each working day, which is quite probable, as $1,000 were produced for each day's washing of the first season. After completing the Smartsville mining ditch, and notwithstanding all experimenting, $750,000 have already been expended on improvements. The stock, which is $4,000,000, is valued at 75 per cent., and will pay, it is said, 2 per cent. monthly on that amount.
>
> The bringing of water to this ground in such abundance was certainly a gigantic enterprise, and the result will probably continue, as thus far, proportionately great. This lead is said to extend from about eight miles north of Cherokee to Thomson Flat in the south, and is from two to four miles wide. It can be justly claimed as one of the richest and most extensive gravel-deposits in the State.

During the year several important discoveries of rich gold-bearing quartz were made in the vicinity of Forbestown. It is said that, in one instance, $4,392 was taken out in two days by the use of a common hand-mortar. The vicinity of Forbestown is likely to become the scene of active quartz-mining before the close of 1874.

Mr. Charles Waldeyer, of Cherokee Flat, furnishes to me the following statement of the operations of the large companies in that vicinity:

The hydraulic-mining interest at Cherokee, Butte County, California, is, so far, chiefly represented by the Spring Valley Canal and Mining Company, which was formed in February, 1873, by the consolidation of the old Spring Valley Canal and Mining Company and Cherokee Mining Company, with a capital stock of $4,000,000. This consolidation enabled the parties interested to introduce to their rich mining-ground, covering about one hundred acres, a sufficient and permanent supply of water from Butte Creek.

The canal, or ditch, which conveys this water is twenty-eight miles long from Butte Creek to the Cancow Valley reservoir, whence it is carried by the old Spring Valley Canal and Mining Company's ditch, through the great inverted syphon, or pipe, to Cherokee. Before the Cancow Valley reservoir is reached, Little Butte Creek is crossed by an inverted syphon 30 inches in diameter and about 1,000 feet long, with a depression of 148 feet; and also the west branch of Feather River, or its north fork, by an inverted syphon of 30 inches diameter and about 3,600 feet in length; greatest depression, 680 feet. The heaviest iron used in the construction of the pipe is $\frac{5}{16}$-inch boiler-iron.

Part of the Butte Creek ditch was constructed by the former Cherokee Mining Company, in 1871. This part of the ditch, about fourteen miles in length, passes over a very difficult terrain, and needed a great deal of blasting, fluming, and filling up.

The expenditure for these fourteen miles of ditch, 5 feet wide and 3 feet deep, including a very excellent dam in Butte Creek and a tunnel about 100 feet long which opens into Butte Creek, are stated to be about......	$40,000 00
And the additional expenditures to convey the water farther, to the reservoir at Cancow, are as follows: 4,619 feet of iron pipe, including transporting and laying..	38,677 42
Ten miles of new ditch, to a great extent in hard bed-rock, and widening of fourteen miles of old ditch..	48,558 79
So that the total expenditure for the new ditch amounts to...............	127,236 21

The work on the recent improvements was commenced April 9, 1873, and was finished July 4 of the same year.

The Spring Valley Canal and Mining Company produced, since its consolidation, from February 1, 1873, to May 15, 1873, in gold bars.............	$129,000
The water failing at the latter date, and the Butte Creek water not being within reach, the mines were suspended for two months. After the introduction of the Butte Creek water, and from July 20, to October 20, 1873, in two "clean-ups," the sum of..................................	120,000
was secured. The largest gold-bar ever cast by a mining company in California, valued at $71,500, was the result of the last of these "clean-ups."	
Since then, viz, from October 20, to December 20, 1873, another "clean-up" was made, amounting to..	61 000
So that seven and one-half months of actual work produced..............	310,000

This favorable result must be the more surprising when it is stated that only 1,000 inches of water were used for washing purposes, as the low state of the rivers—the consequence of two dry winter seasons—prevented a greater supply.

The Irish Mining Company owns about five acres of the most valuable mining ground, and works during the rainy season by the hydraulic process, the water-supply depending altogether on the rains of the winter season.

The "Blue lead" has developed very rich in the above claims, gold being visible throughout in the gravel, and a steady and sufficient supply of water would make these mines the most productive in the State.

How desirable and remunerative the introduction of a large supply of water to the mines of this vicinity would be must be evident when it is considered that a number of mining concerns, among these the

Cherokee Flat Blue Gravel Company, with 900 acres of the most valuable mining ground, are idle and unproductive for want of this all-important element. In fact the mining region is not confined to the great Table-Mountain lead, which goes from Cherokee past Morris's Ravine, where the rich Hendricks Company's hydraulic mines are situated, to Thompson's Flat, opposite Oroville, but extends to the Dogtown Table Mountain and its spurs, to which latter that gravel-deposit belongs which is recently opened at Saint Clair Flat, about two miles northwest from Cherokee, by the Cherokee Consolidated Mining Company.

This mine is owned by Messrs. Thomas L. Vinton and Williams, of Cherokee, who have opened it and work it by the hydraulic process. The area of the mining ground covers about 40 acres, and it develops in a very promising style—blue gravel in the bottom, and yellow-gravel deposit, intermixed with a great deal of quartz, on the top. A bank 40 feet in height is now exposed. The improvements consist of open bed-rock cuts, with 3,000 feet of 30-inch flumes, and 500 feet of 15-inch iron pipe to convey the water, under 150 feet pressure, to their "hydraulic chiefs." The cost for opening and improvements amounts to about $10,000. The water used, about 400 inches, is supplied by the Hendricks ditch. The gold is coarse and fine, mixed, and the yield has been from the very beginning sufficient to insure a handsome monthly dividend.

A number of other mining companies are now busy opening mines in the same deposit; and all of them have the best indications of success, provided a sufficient quantity of water can be secured to work steadily.

The following description of the extensive hydraulic claim of Hendricks & Brothers is from the columns of the Oroville Record:

> The Messrs. Hendricks, in Morris Ravine, have a vast mining claim of excellent pay-dirt, with the best appliances, and water to work it. The extensive gravel-deposit into which their 2,500 inches of water, under several hundred feet pressure, are cutting their way, is unmistakably of the same character as the deposits at Cherokee, and will not fail to be equally as remunerative. Their mining flume, which lies deep down in the bed-rock at the claim, extends down the ravine for a distance of a mile or more, is 4 feet in width, of firm and substantial structure, and paved with rock. It is their design to extend the flume down the ravine to Feather River, a short distance above Oroville, and opposite river-claim of '57, known as the famous Cape claim. It was the theory of the speculator then that the rich deposits found in the famous Cape were washed down Morris Ravine from the deposits underlying Table Mountain. Morris Ravine itself was one of the rich and famous surface-mining ravines of '49 and '50, and strengthened the theory of the river-deposits. The ravine, from its confluence to the claim of Messrs. Hendricks, has been little more than skimmed off, while such claims as the Monte de Oro, and those of Rigby and Boyd, high up on the mountain-sides of the ravine, show that the whole formation is a deposit of auriferous earth. The ravine itself shows evidence of having only been slightly scratched over, while the claims above referred to having been worked successfully for years, yet seem to be nothing more than mere scars on the mountain-sides. Doubtless a much greater impression could have been made on those huge deposits, but for the small amount of water afforded by the water-shed of Table Mountain, and some of them, (the Monte de Oro, for instance,) being situated so high on the side of the mountain as to afford but very little water during seasons of the greatest rain-fall.
>
> The Messrs. Hendricks appear to have mastered the situation so far as a supply of living water for their own use is concerned, by the construction of a ditch some fifty miles in length, taking water from the west branch of the Feather River, conveying it across depressions in huge iron pipes and around the mountain-sides in ditches. This large ditch, carrying 2,500 inches of water, winds around the hills in the vicinity of Cherokee with tantalizing placidity to the miners of Cherokee, whose rich claims lie idle a good portion of the year for want of the flood of water that runs at their very feet, but the ditch was not calculated for that altitude, and it gracefully curves from their view, clinging to the crumbling sides of the North Table Mountain, until it debouches into a vast reservoir at the head of Morris Ravine. From thence it is carried in pipes, under several hundred feet pressure, to the claim. Here a distributor divides the current into three pipes, to each of which is attached a hydraulic chief, which hurls 800 inches of water against the face of the claim with great and irresistible force, before which the earth melts away, and even the bed-rock is torn up and thrown high

in the air, shivered to atoms and whirled away down the flume by the rapid current. These hydraulic chiefs are operated each by a single man, and after the flume is laid, and the mountain loosened with powder, do the work of mining.

On a recent visit to this claim, we witnessed the power of one of these monitors in cutting a passage through the bed-rock for the flume. It was stationed above the head of the flume, and hurled 800 inches of water through a 5-inch nozzle on to the bed-rock in the direction of the head of the flume, cutting its way through the rock with the apparent precision and ease of a gardener's spade in yielding soil, and almost with the rapidity of electricity. It is but recently these vast arrangements have been perfected on this claim. Indeed, the large 4-foot flume is not yet completed to the face of the claim, and it will be but a short time before the claim of Messrs. Hendricks will equal, if not excel, any other hydraulic mining operation in the State. Blasting tunnels have been run into a mountain almost as large as one of our Buttes, which will soon be shattered by a blast fired by electricity, the buildings in the vicinity being barricaded by planks to protect them from the falling *débris*. The hydraulic chief, under the direction of a single man, will do the balance of the work. Much coarse gold is found on the bed-rock in their claim. A piece weighing over 4 ounces was picked up the morning of our visit. The Messrs. Hendricks have expended a large sum of money in making these extensive preparations for mining.

SIERRA COUNTY.

This county is bounded on the north by Plumas and on the south by Nevada County. The great gravel-range known as the Blue Lead, rising in Plumas and Lassen Counties, runs through this county, and is extensively mined at Forest City, Laporte, (on the line of Plumas County,) Saint Louis, Howland Flat, Port Wine, Hepsidam and other places in the county. My report of last year contains a detailed description of the various channels running through the county. Since it was written, important discoveries have been made in the vicinity of Forest City, which are described by Dr. Henry Degroot in a letter to the Mining and Scientific Press of San Francisco. Doctor Degroot says:

Forest City has experienced its full share of the vicissitudes common to most early mining camps in California. The ravines in the neighborhood, enriched by the Blue Lead, which crosses the country here, paid when first worked most liberal wages. With the partial exhaustion of these deposits the more exposed and easily-reached portions of the main lead were attacked through drifts and shafts, and for a number of years some twenty or thirty companies, employing several hundred men, did well at this business. Meantime, many tunnels were started for those sections of the old-river channel that were more deeply buried or supposed to lie farther back. Then came the era of stampedes, when the California miners, eager to exchange these supposed impoverished diggings for virgin placers, and ignorant of the buried wealth they were abandoning, hurried off to distant fields of labor, leaving their claims and often costly improvements, most of which afterward fell into a state of irreparable decay. Neglected so long, the tunnels caved in and the shafts were filled up; and when these men came back, as many of them did, they found their grounds in the possession of others, or the works that had cost them so many hard days' labor well-nigh useless.

During this period of absenteeism two or three companies kept work going on their claims, the principal of these being the Live Yankee, who owned a tract having a frontage of 360 by a depth of 2,600 feet on the Blue Lead south of the town. This was opened by a long and costly tunnel, commenced now nearly twenty years ago, and which was afterward maintained in a state of repair at considerable expense. From 1854 to 1863 inclusively, this company took out $713,777, of which nearly one-half was paid out in dividends. After this the net earnings fell off materially, the dividends amounting to only about $10,000 per year. The richer portion of the gravel being washed out nothing has for some time past been done on this claim; though it is possible it may yet be worked by hydraulics or portions of it be re-opened for drifting purposes.

The Highland and Masonic claim, another of those that were worked for a long time without intermission, lies near the town, and has had a checkered history. It was first opened by means of a shaft and supplied with costly hoisting and pumping works, which were afterward burned. The yield was large, but owing to the original outlay and heavy current expenses not much profit accrued, and the claim was finally sold for debt. It was afterward opened by a long bed-rock tunnel, and for a time turned out as much as $100,000 per month, after which it again fell off and finally dwindled away to almost nothing. The water in this claim, notwithstanding the quantity is considerable, is so acidulous that sheets of zinc exposed to its action are soon eaten up, and shovels left in it for a short time are so eroded as to be unfit for further use.

The North Fork is another of these old companies that, with some intervals, have kept work in progress about Forest City. They own a very extensive and valuable section of the Blue Lead adjoining the Bald Mountain ground on the northwest, and which they are now opening with a bed-rock tunnel, already in over 2,000 feet, with about 1,000 more to run before reaching the channel. They have been at work on this tunnel several years, and it will probably require another year to complete it, much better progress being made since the single hand-drill and giant powder were introduced.

The only largely-productive claim, however, in the immediate vicinity of Forest City, and that which now imparts more life and business to the place than any other, is that of the Bald Mountain Company, situate close to and a little north of the town. The members of this company, twenty in number, are mostly working miners, who deserve great credit for the industry and perseverance as well as the good judgment shown in opening their ground, which covers a broad space on the main Blue Lead. The tunnel, nearly 2,400 feet long, is a well-constructed and costly work, the most of it performed by their own labor. They are meeting with a merited success, which, besides enriching themselves, is likely to prove of great benefit in encouraging other parties owning grounds here to go ahead and open them up.

The experience of this company is of value in showing that parties going after these old channels should not be discouraged, even if the first gravel reached fails to come up to their hopes, or if they meet with other disheartening circumstances in the exploitation of deposits so unique in themselves and marked often by great eccentricities. When 500 feet in, some auriferous gravel was found on top of the bed-rock, but it was of very low grade. A thousand feet in, another streak was encountered of somewhat better character, but still not rich enough to warrant removal. At 1,300 feet a shaft was raised 12 feet above the tunnel, when a three-foot stratum of gravel, blue and compact, was broken into, which, on being prospected, paid at the rate of $3.19 per car-load. They pushed ahead another hundred feet, when, raising up again, they broke into a thin layer of dark-blue gravel, exceedingly hard and well stocked with gold, showing that they were in the rich pay-streak of the main lead.

For the first 250 feet in, the tunnel of this company was run on a low grade. At this point the bed-rock was encountered, indicating the necessity of a raise; 500 feet in, the grade was made still steeper—1 foot in 12—which was maintained for some distance. The bed-rock, composed here partly of serpentine, but mostly of talcose slate, rises and falls at certain places in a manner to greatly perplex the miner, tempting him sometimes to raise his tunnel only to find, after proceeding a short distance, that he has been betrayed into a mistake.

Finding the inner extremity of their main tunnel too high, this company have obviated this trouble by two branches, the one starting out to the left 1,200 feet in, and the other to the right 1,400 feet in, and which, after making a slight elbow, turn and run nearly parallel with the main tunnel, but on a lower level. Through these side tunnels the gravel is now brought out; 1,800 feet in, a turn-out 100 feet in length has been constructed, where the cars pass each other. The stratum of pay-gravel here varies from 2 to 4 feet in thickness; but most of it is so very hard that only about 1 foot, and often not more than 6 inches, of the richest portion is removed; and in breaking out this, the gad, and sometimes also blasting, has to be employed. After removal, much of it has to be crushed with a sledge-hammer before the gold can be extracted from it by washing. Scarcely more than two-thirds of the gold-bearing gravel is taken out, the balance being left with a view to its being hereafter extracted and crushed with stamps. Although the company have over a mile of sluices set along Oregon Creek, much gold is necessarily left in the tailings, which will also at some future time be worked over. To make room for the drifters, the top of the bed-rock, here much decomposed, is removed for 2 or 3 feet. Though so friable, it carries no gold to a greater depth than 2 or 3 inches, nor is any found in the crevices and pot-holes, the latter being filled with bits of wood, leaves, and sand.

Although several hundred feet of fine gravel had before been penetrated, no main gangways were run until 1,800 feet in from the mouth of the tunnel. They are 300 feet apart, the sub-gangways being 65; the latter, where the gravel is extremely hard, being sometimes wider, as it is found cheaper to shovel the dirt a greater distance than to cut numerous gangways.

A great economy has been effected here in substituting giant-powder and the single hand-drill for the old style of explosive and mode of drilling; the men preferring the former, as they allege, on the score of both health and comfort.

It was only during the past summer that the Bald Mountain Company got their dump-yard, sluices, and other outside works in shape, and commenced running out gravel. They have since extracted some 20,000 car-loads, which will average very nearly $10 each, their estimate being half an ounce to the car-load, and this gold being worth $18.30 per ounce. It is mostly coarse and easily saved when once freed from its containing cement and gravel. It is the intention of the company to employ

100 hands as fast as suitable men offer, they having a preference for whites and old Californians. They pay $3 per day in gold—board and lodging at the hotels in the town $7 per week. This company have ground sufficient to last them for a great many years, indeed so long that this feature is not much consulted in estimating the value of their mine.

In the latter part of the present year, (1873,) this company, after two weeks' drifting and one week's washing, cleaned up 11,000 ounces of gold, worth $18 per ounce, or $198,000 for the run.

The county has twenty-four quartz-mills, which, according to the assessor's return, crushed 68,000 tons of quartz in 1873, against 74,000 tons in 1872. With the exception of the Sierra Buttes, the leading quartz-mine of the county, owned in London, I have received no returns. The returns of this company have been given on a previous page under the general head of "Quartz-Mining."

The Sierra Buttes mine is situated near the summit of a prominent mountain-peak of the same name, at an altitude of about 6,000 feet above sea-level. The mine was discovered in 1851 and the first mill erected two years later. From that time until 1857 there are no records of its production. In 1857 it yielded $51,000. From that year to 1868 the production increased gradually and steadily, and in 1868 reached $220,000. The total yield from 1857 to 1868 was $1,844,000, of which $1,139,000 was disbursed in dividends. Between 1868 and 1870 large sums were expended for machinery and improvements, but dividends were paid. In 1870 the mine passed into the hands of English capitalists, and was incorporated in London, since which time an aggregate of $550,000 in dividends has been paid to the London owners, and further extensive improvements have been made, involving the expenditure of large sums of money. Since the English purchase, the product has been as follows: July to December, 1870, $103,300; 1871, full year, $390,200; 1872, full year, $387,000; January to July, 1873, $206,000; or a total of $1,086,900. The reserves in sight justify an expectation of dividends for many years.

This county also possesses extensive beds of iron-ores, now being developed by the Sierra Iron Company. The ore-deposits of the Sierra Iron Company are situated near the boundary-line of the State of Nevada and about sixty miles from the Central Pacific Railroad. The ore is a magnetic oxide of iron. It is estimated that the average of all qualities of ore will yield one ton of iron to two and one-half tons of ore. In the same neighborhood are found fluxing materials in abundance, together with large tracts of timber-land suitable for charcoal and other purposes.

Further details of the operations of this company, together with a description of the character of ore, mode of occurrence, and geological formation, from the report of Clarence King and James D. Hague, have been given in previous pages under the general heading Iron and Coal.

PLUMAS AND LASSEN COUNTIES.

These two counties are situated in the High Sierra, north of the line of the Central Pacific Railroad, and present many points of similarity in their geological and topographical features. Here, according to one theory, arose the great dead rivers of California, which, flowing southward, were, during an era recent, geologically, but remote in centuries, covered by the lava-eruptions from craters, the peaks of which are easily recognized by the traveler in this portion of the State. Nearly all the shallow places, ravines, and flats, to which water could be conveyed, are worked out; and miners are now turning their attention to the development of the deep placers. Miners believe that the Blue Lead can be traced through from Moore's Flat, Minnesota, Clipp's Flat, Alleghany, Forest City, Goodyear's Bar, Monte Christo, Port Wine, Saint Louis, Howland Flat, Gibsonville, Whisky Diggings, Onion Valley, and Sawpit Flat to Feather River, and thence through this county south of Clermont Hill.

An intelligent correspondent of the Plumas National says of this channel:

> We are fully aware of the fact that the same characteristics exist in the bed-rock reached by Myers & Siler on Clermont Hill as exist in the Blue Lead at Forest City, Sierra County. The bed-rock is a soft, friable shale or slate, either white or blue, in the crevices and pot-holes of which remains of plants and animals are sometimes found in a fair state of preservation. Again, the outcroppings of the rim-rock are plainly visible and easily traced all along this rich channel; and here we may observe in passing, that the indications presented on the ridge east of Quincy point to the existence of auriferous deposits in that direction. And why? Simply because all the gulches and ravines in this ridge have paid well for working in former years. From this we may conclude that a basin or channel exists in this direction, extending from Argentine by way of Squirrel Creek, through above Mill Creek, and falling or emptying into the Blue Lead Channel, at or near Clermont Hill.

Among the extensive operations now in progress are the works of the Hungarian Hill Company, situated near Quincy, the North Fork Company, and several companies in Argentine district.

The Hungarian Mining Company purchased the claims on which it is now operating a little less than a year ago for the sum of $50,000, and at once commenced the work of introducing all the modern improvements in hydraulic mining. The company has already laid out over $50,000 in improvements, and is still under heavy expense. Thousands of feet of huge iron pipe have been laid, large flumes have been built, reservoirs constructed, miles of ditch dug, and still the work goes on. The company is now piping in what is known as Quigley's Ravine, on the west end of the diggings. The flume here is in four sections, making a length of 1,800 feet. The flume is very substantially built, is 4 feet 8 inches wide inside the blocks, and on 6 inches grade works well with 1,000 inches of water. Two large undercurrents catch all the fine dirt, and it seems impossible for the gold to escape. Between the sections of flume are ground-sluices so arranged as to break up the dirt, which might otherwise pass off in "chunks." The bank of gravel at this place is from 100 to 200 feet deep, and contains gold from the surface to the bed-rock. Two large "giants" are worked against the bank, throwing some 900 or 1,000 inches of water. With a pressure of 300 feet these pipes keep the flume constantly filled to its full running capacity, and the bank seems fairly to melt before their almost irresistible power. Rocks weighing hundreds of pounds are tossed about the flume to land in the cañon below. In the old workings on the north side of the claim the company has constructed a new flume 3 feet wide through the whole length of the tunnel, and at the lower end has placed undercurrents sufficient, it seems, to render the escape of gold impossible. The main pipe is finished to this point also, and two or three days' work will place the remainder of the machinery in position to commence piping. Here the former owners did all their work on these claims, and, from their noted richness, the yield under the present appliances must be immense. The company own about one hundred and fifty acres of ground.

At Dutch Hill the North Fork Company has shown the practicability of working rich placers profitably by elevating water by pumps driven by steam. At a point on Ohio Creek, about ten miles from Prattville, this company has constructed a dam, from which, through a No. 10 iron pipe

6 inches in diameter, water is pumped to the distance of 700 feet and to an elevation of 328 feet. At that point the water is received in a large reservoir, and is thence conveyed four miles through a flume to the diggings. The gold is coarse in character, the gravel-wash extensive, and the deposit rests upon a slate-bed. In proof of the surprising richness of the mine the company had a clean-up lately from an eight days' run, which yielded the snug sum of about 200 ounces of gold.

The following account of Argentine district is condensed from the Plumas National:

Twelve miles to the east of Quincy is a notable mining locality, now known as Argentine. The placers and gold-bearing ledges are mainly situated along Squirrel Creek, and were familiarly known to old settlers as Greenhorn Diggings. The present name of Argentine was given by a company which, some years ago, discovered in the vicinity a silver-bearing quartz-ledge. For a time much labor and money were expended in digging tunnels, sinking shafts, and performing other labors upon the silver-lode; but the mine proved valueless, and the work was abandoned. Two miles to the east of the silver-lode, and directly in the gold-belt which stretches from Big Meadows, via Indian Valley, to Jamison, are situated the extensive quartz mines and mills belonging respectively to J. W. Duesler, Hobart Brothers, and the Keystone Company. At the same point is the great hydraulic placer-mine belonging to E. A. Heath. The placer-claim, which is one of the largest, and also one of the richest in Plumas County, is remarkable as being probably the only rich and extensive mine of this class in the country, in which there is little or no gravel-wash. At the surface the mine presents the usual accompaniment of red earth and tertiary sands, with here and there a streaking of gray volcanic ashes. The bed is yellow clay-slate, iron-stained shale, and fragments of silicious blue schist; but the usual gravel-drift is almost totally absent. The gold is exceedingly fine, and seems to come directly from decomposed auriferous quartz-seams which abound in the clay-slates on the upper or eastern side of the excavation.

Duesler's quartz-mine lies to the south of Heath's placer. South of Argentine crops up the great blue serpentine ledge, which is clearly traceable from Big Meadows to Jamison. At Duesler's mine a volcanic dike of gray trachyte lifts its unwelcome form exactly in the center of the quartz-deposit, and has literally torn the ledge into fragments. Through ignorance of this seismic disturbance many years of hard labor and many thousands of dollars have been fruitlessly expended in the vain endeavor to find a true-fissure ledge in the heart of this obdurate basaltic mass. The hill has been completely gophered, gullied, and honey-combed in every possible direction, for the broken and distorted stringers of quartz have been thrown into every conceivable position and trend by the disturbance. The quartz obtained from this fractured mass has always yielded good pay; and there are substantial reasons for believing that, if the ledge is opened at a point remote from the volcanic dike, it may be profitably worked.

No returns were received from Indian Valley, formerly an important quartz-district. The returns from the "Plumas Eureka" quartz-mine, of London, situated in the eastern portion of the county, are given under the head of Quartz-Mining on a previous page of this chapter. A very fine and valuable deposit of pyrolusite, assaying $86\frac{6}{10}$ per cent. of binoxide of manganese, has been discovered contiguous to the large iron-deposits of Plumas County. In the same region there exist large deposits of sulphate of baryta, and of fine clay, steatite, and asbestos, accompanying the copper and iron lodes of the county.

Mr. W. F. Stewart visited Lassen county during the fall of 1873, and contributes to the Mining and Scientific Press the following description of some of its resources:

Lassen County is mainly adapted to agriculture, and also to cattle and sheep raising. It is easily accessible, either from the Sacramento Valley via Chico, or by the daily stage-line from Reno. From the last-named place to Susanville the route passes through Long Valley, Honey Lake Valley, and Susanville Valley. The scenery is picturesque and the road almost a level, all the way. For twenty years past gold has been found in paying quantities along Gold Run and other streams in this county, but the extent and richness of its placer gravel-beds were not fully understood until within the past two years. That gold existed at Haydon Hill and copper at Big Meadows, has been known for a longer period; but more recently miners discovered that the gravel-deposits were not only extensive, but richer than any hitherto known. Something more than a year ago attention was attracted to an enormous gold-bearing gravel-bed on the very apex of the Sierra Nevada, a few miles south of Susanville. Parties are now engaged in developing this mine, and the wonderfully-rich prospects which they have found encourage the belief that their labors will be crowned with success.

Infinitely beyond Diamond Mountain, and beyond anything which I have seen in this region as a placer-deposit, is the Susanville gravel-mine, near Big Spring, twelve miles west of Susanville. Recently Mr. Isaac Branham purchased a large interest in this mine, and is now actively engaged in cutting a ditch to the works. The mine is a tertiary gravel-bed, having a visible length of one and a half miles from north to south and a length of one mile from east to west. On the north, west, and south the gravel is covered by an outflow of lava as at Cherokee. On the east the mine is bounded by a rim of solid granite. In brief, the mine is a gold-bearing gravel-basin of surprising richness. The Susan River, containing, for most of the year, 2,000 inches of water, runs directly through the heart of the bed, and can be easily brought to bear directly upon the mine by making a ditch, or flume, three miles in length.

The gravel-bed has the remarkable depth of about 60 feet, and yields pay-dirt to every panful of gravel from surface to bottom. It is easily washed, and unlike the famous deposits at Cherokee, Morris Ravine, and other gravel-beds, it is not the least encumbered with heavy strata of sand, clay, bowlders, and other hinderances, but is very rich pay-gravel from top to bottom. There is a splendid fall for undercurrents. It is also easy of access.

A correspondent at Haydon Hill says: "Everything here is at a standstill, and has been for some months. What with quarreling among the owners and salting mines, imperfect developments, failure to find any permanent veins, and lack of a sufficient quantity of paying-rock, things look decidedly blue. One thing is certain—there is gold here somewhere, for in the clay filling of the small fissures gold is obtained in considerable quantities, and the soil all over the hill, to the very ridge, shows gold, but as these fissures are generally but a few inches wide not enough can be got out to run a decent mill. This is the more to be regretted as the neighboring country depends largely on the welfare of these mines."

List of mills in Haydon Hill Mining District, Lassen County, California.

Name of mill and owners.	Location.	Power.	Horse-power, engine.	No. of stamps.	Weight stamps.	No. of drops per minute.	Height of drop.	No. and kind of pans.	No. and kind of concentrators.	Cost of mill.	Wood consumed per 24 hours.	Crushi'g capacity of mill per 24 hours.	Loss of mercury per ton.	Cost of treatment per ton.	Running time.
					Lbs.		*In.*				*Cords*	*Tons.*			
Old Providence Mill, Old Providence Mining Company.	Paradise City, Haydon Hill.	Steam.	About 12	Crusher and pulverizer.	....	....	....	1 barrel, 1 settler.	....	....	3	240	Not estimated.	About $5 00	Not running.
New Providence Mill, J. Mee.	Klinger's Ranch, Haydon Hill.	Steam.	About 30	20	750	70	8	....	...	About $20,000	3	40	....	2 50	About 3 weeks.

REMARKS.—The Old Providence Mill was formerly supplied with 8 stamps, (560 pounds,) 2 old-style pans, and 1 settler; these were replaced by one of Whelpley & Storer's crusher and pulverizer, with a barrel for amalgamating, and the old settler, after three days' running the engine, was found insufficient; since then everything has stood idle, but fresh operations are intended in the course of a month. The New Providence Mill has shut down, after running three weeks during the day-time, to await further developments. A third mill, of 20 stamps, was in course of erection, to be driven by water-power, but all work thereon has, likewise, been suspended for the present for similar reasons. Besides these there has been an arastra working part of the time during the year on rock from the different claims.

List of producing-mines in Haydon Hill District, Lassen County, California.

Name.	Owner.	Location.	Course.	Dip.	Development.		Country rock.	Vein-matter.	No. tons extracted and milled during year, July 1, 1873, to July 1, 1874.
					Depth of main shaft.	Total length of drifts.			
					Feet.	*Feet.*			
Old Providence Mining Company..	Incorporated Company.	Haydon Hill, Lassen County.	N. E. and S. W.	S.	115	....	Porphyry breccia	Clay and bastard quartz.	None extracted since July, 1873.
New Providence Mining Company.	....do	....do	....	.....	70	500	......do	......do	Between 200 and 300 tons.

REMARKS.—There is, in reality, no producing-mine in this district at the present time, and, so far as the developments on the numerous claims are concerned, I do not consider there has been a single vein struck. Numerous small fissures have been found filled with a heavy clay, and some exceedingly rich in gold, but, so far as traced, of no great length or depth. Before this district can take its place as a legitimate mining district a good deal more work has to be done, and in a more systematic manner. The whole country has been broken up by volcanic action, and although men have been at work on the hill for the last three or four years, and one claim has taken out over $40,000, as little is known about the source from whence the gold has come as when the work was first commenced. For my own part, (says the correspondent to whom I am indebted for the above information,) after examining the hill, I think the main supply of gold in the water-fissures, where found, has come from a ledge somewhere in the top ridge of the mountain, where at present no developments have been made.

SHASTA COUNTY.

The principal mineral region of this county lies west of the Sacramento River. This county at one time supported a large population engaged in placer-mining on the various creeks, which, rising in spurs of the Coast Range, have cut through one of the dead-river channels, and enriched their beds from this point to the plains below. The topography of the auriferous ground is here an elevated plateau, intersected at right angles by modern streams which have worn their way to the bed-rock of the old channel and dispersed its contents over the low rolling hills and the plains below, almost down to the Sacramento River, a distance of fifteen or eighteen miles. Some of these creeks have been noted for their enormous yield of gold. Among these are Dry Creek and Clear Creek. During the fall of 1848, shortly after the discovery of gold, Major Redding, one of the pioneers of California, with the assistance of a few Indians, and the rudest of appliances, took out from the bed of Clear Creek over $60,000. Subsequently the towns of Shasta, Horsetown, and Piety Hill were built, and maintained a large mining population for many years, until the beds and bars of the creeks had been worked over several times. Among the richest of these streams was Dry Creek, in the vicinity of Piety Hill. Here, in 1853–'54, W. K. Conger worked out a claim 20 by 60 feet from surface to bed-rock, a depth of 30 feet, and took out $22,000 from this small claim. In 1852 a Mr. Cooper worked 200 feet of the line of channel of this stream, and took out $170,000. At a later period, F. A. Jones worked a claim on Dry Creek which yielded on the bed-rock $1 per bucket. The Scott crevice also yielded an almost fabulous amount. Numerous other but somewhat less authentic instances could be given, to demonstrate the richness of the ancient channel which has fed the modern streams.

Following the exhaustion of the surface-placers the country was rapidly depopulated. The once lively mining camps and prosperous towns were deserted and remained in this condition until the construction of the Oregon and California Railroad infused a new vitality into both the agricultural and mining interest of this county.

Within the past five years the mining-ground between Clear Creek and Dry Creek, in the vicinity of Piety Hill and Horsetown, has been concentrated by relocation of abandoned ground, purchase, and location of new grounds in the possession of a company incorporated as the Dry Creek Tunnel and Fluming Company, and under the management of Mr. George F. MacPherson. The grounds of this company embrace 1,732 acres, of which less than 100 acres have been worked out, and this portion only on the rim-rock. In opening this ground so that the most recent hydraulic improvements might be applied to its working, great difficulty was encountered in securing a tail-race. Dry Creek was flat and afforded none; but a survey established the fact that the bed of Clear Creek was several hundred feet below that of Dry Creek. A tunnel and deep cutting from creek to creek was made. It is 2,400 feet in length, and has occupied two years' time in construction, and used over 200,000 feet of lumber. It terminates at a point near the center of the company's claim, 100 feet below the surface of the ground on the bed of Dry Creek, having its outlet on Long Gulch, a tributary of Clear Creek. Shortly after its completion a sudden rise of Dry Creek swept a vast volume of water and drift-wood through the tunnel, breaking the timbers and caving the tunnel for a distance of several hundred feet. This unfortunate accident, rendering ineffectual a work which had cost $48,000, occurred before the boxes had been cleaned up on the first run.

The company at present have only a limited supply of water, but have surveyed several ditches which will afford them about 2,000 inches during eight months of the year. The surface-gravel, being the *débris* from the surrounding hills, which are auriferous, is rich, having paid an average of 50 cents per cubic yard. The blue gravel underlying the upper strata yields fully as well. These deposits have no volcanic superstratum, but consist of a mass of auriferous red and blue gravel, deposited in regular layers, and yielding more or less gold from top to bottom. The bed-rock is in a hard, metamorphic slate. Prospective tunnels have been run hundreds of feet in almost every direction, and upward of forty shafts have been sunk to bed-rock, exposing, in every instance, the same quality of gravel. A tail-race, 1,500 feet in length, has been cut through hard, blasting rock, in some places 15 and 20 feet deep, at a cost of over $25,000. The company's ground is divided by a high rim-rock, which separates what appears to be two distinct bodies of auriferous *débris*. The most easterly, where the tunnel above described runs through the ridge from Clear Creek to Dry Creek, presents the appearance of a channel, while the deposit on the west side of the rim seems to be a basin formation. On the east ground a washing of 50,000 cubic yards yielded $9,000, or an average of 18 cents per cubic yard. On the west side 2,000 cubic yards gave $741.26, or an average of 37 cents per cubic yard. Extensive improvements for the purpose of bringing water from the mountains west of the auriferous belt are now in contemplation, and such works are fully justified in view of the character of ground exposed by the tunnel through the ridge, and the other deep workings of the Dry Creek Tunnel and Fluming Company.

On the mountain-range to the west are found several veins of silver-bearing quartz, which were visited during the present year by Dr. Henry Degroot, who furnishes the following information:

> Several years ago some excitement arose regarding quartz discoveries in Shasta County, but it soon died out. The ore was refractory. The necessary machinery was expensive and almost unattainable at that time. The knowledge how to work such rock was limited, and sundry other causes united to bar further progress. The ledges are situated in a chain of rugged mountains, already referred to. West of Piety Hill the ledges crop out boldly in granite near its junction with slate formations. They are numerous and well defined. The gangue is quartz, and the pay-ore blackish sulphurets of silver, carrying also a small quantity of gold. The ores are base and require roasting before yielding their treasures. In ascending the hill the first vein of any consequence is the Crystal. This shows for half a mile by croppings. A shaft 80 feet deep has been sunk upon it. Rock 10 feet from the surface only assayed a few dollars, but from the bottom of the shaft gave $360. Several tests were made from other parts of the vein equally satisfactory. This claim was purchased by San Francisco parties, and a contract has been let for the extraction of one hundred tons of ore. It is the intention of the owners to sack the ore and ship it to San Francisco for the present. Farther up the hill lies the "Cincinnati." Some little work has been done on this vein at a point where it has been crossed by a mountain-stream. Enough was extracted to give a fair working test. It paid $200 per ton. Still farther up the mountain lies the "Chicago." A small five-stamp mill and furnace are at work on this vein. On account of limited facilities for working, the rock extracted is selected with scrupulous care, and only such as pays $400 and $500 per ton is worked. In this vein, on the hanging wall, is found a thin seam of ruby silver. Considerable work has been done on other claims in this vicinity.

KLAMATH COUNTY.

This county, situated in the northwestern part of the State, is noted principally for its "gold-bluffs," which have been worked for many years for the auriferous sands found on the ocean-beach, where the bluffs are washed by the surf. These mining operations are peculiar to California and Oregon, but very little seems to be known concerning them. To the accounts given in former reports I add this year some fresh material. In 1850 a party of adventurers traveled from Trinidad up the coast, seeking for the mouth of Trinity River, which, instead of being in reality an affluent of the Klamath, was supposed to have a separate mouth. At a spot on the beach they saw glittering particles in the sand, which on examination proved to be gold. After collecting some of this gold they went back to Trinidad to procure provisions, &c. On their return, however, they found nothing but a bed of gravel, a change in the direction of the surf having carried away or covered up the gold. It may be remarked that when the direction of the wind is such that the surf breaks square on the beach it rolls up masses of coarse gravel and no black sand is visible; but when it cuts the beach at an angle the gravel is washed into heaps in certain spots, and in others black sand is deposited, more or less rich in gold. After the discovery mentioned above, ensued the famous "gold-bluff excitement," well remembered by many early Californians. The beach-sands were worked in rockers and sluices. From that time to the present these beaches have been steadily worked, the highest amount taken out in one year up to the present being said to be $25,000 for the lower claim. The proprietors have, however, labored under the disadvantage of a scanty supply of fresh water, not being able to keep their sluices running more than one-third of the time.

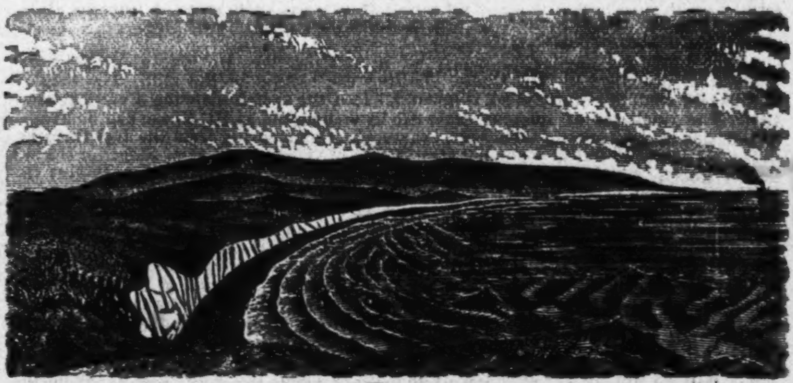

FIG. 1.—The beach at Gold Bluffs, looking south.

At a meeting of the California Academy of Sciences Mr. A. W. Chase, of the United States Coast Survey, read a paper descriptive of these bluffs, and presented drawings showing a general view of the mining-ground and sections of the bluff. I copy an excellent report of his paper from the Mining and Scientific Press:

> He describes the coast-line, coming from the north after leaving the Klamath River, as being extremely broken and rocky. At a point about four miles south of the river, banks and deposits of sand appear, although the commencement of the bluffs proper is at the mouth of the Ossegan Creek, and seven miles from the Klamath. Then for nine miles there is an almost unbroken line of cliffs, varying from 100 to 500 feet in height. Many of the bluffs are absolutely vertical, and in some instances are overhanging. At low water there is a narrow beach, but when the tide is full the sea washes directly against the base of the cliff, the beach being then impassable. A view of the beach is shown in Fig. 1 of our engravings.
>
> The mountains back, of which the bluffs form the sea-escarpment, are all one immense mass of gravel, of varying size and distinctly marked layers or stratifications.

This gravel can be traced across the country northeastwardly to a point on the Klamath River, about thirty miles distant, where the same form of deposit makes its first appearance as you descend the river.

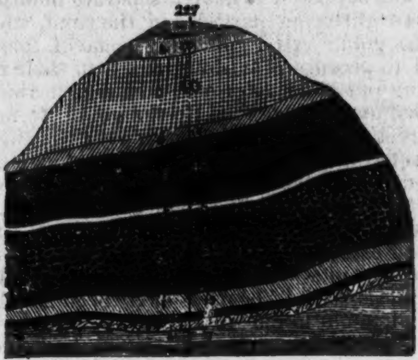

FIG. 2—Section of bluff.

In Fig. 2, A is loam; B, yellow clay; C, yellow gravel; D, sandstone; E, red and yellow gravel; F, sandstone with wood lignite; G, coarse red gravel; H, very fine bluish gravel; I, indurated sand; J, gravel with iron cement; K, sandstone with lignite; L, beach; M, low water mark.

As the bluffs are similar, or nearly so, in stratification, we give a cut (Fig. 2) made from drawings by Mr. Chase, showing the section of the cliff. The height of this cliff from low-water mark is about 227 feet, the sketch showing a vertical section. The thickness of different strata are by estimation, as Mr. Chase had no available means of determining them with exactness. Commencing from the top, there is first a section of 10 feet of loam and then 20 feet of yellow clay; then 40 feet of coarse yellow gravel, which covers a stratum of sandstone of brownish color, 10 feet in thickness. Next in order is 40 feet of red-and-yellow gravel. Then comes 5 feet of a blue-colored sandstone. Projecting from this layer are numerous stumps and other portions of trees partially transformed into lignite. Then there is 55 feet of very coarse red-and-yellow gravel, and immediately beneath it 5 feet of very fine blue-colored gravel. Under this is 15 feet of indurated sand, covering a stratum of 10 feet of gravel, stained a deep red, probably from the presence of oxide of iron. Beneath this is another stratum of sandstone, 5 feet, blue in color, with pieces of the lignite before referred to projecting from it. Then 5 feet more of blue sandstone without any lignite; then 7 feet of gravelly beach to low-water mark.

The cliff described is at the lower end of the bluffs and near the mining-works. The strata all dip up to the north, at an angle of about 15°, while that at the north end, although much broken, seems to dip toward the south. Mr. Chase presented specimens of stratum, No. 10, from the top, in which, on examination, mica and fine gold can be detected with a microscope. The specimen was a concretion, cemented together by the oxides of iron on a large bowlder. Mr. Chase believes that it is from this stratum that the largest amount of fine gold is obtained.

In describing the method of working the mines, he says that he rode up the beach with the superintendent of the lower claim, just as the tide was turning to go out. The practiced eye of the superintendent of the claim noted every indication of the presence of black sand. Alighting at a spot at the base of the cliff, he scraped away the loose gravel, and taking up a shovel-full of the sand lying beneath he panned it out in the littles pools of water left by the receding tide. On finding a "good prospect" he dispatched a messenger to the works, and the mule-train came down. There are some 40 of these animals employed altogether, but in the present instance but 16 of them were used. Each mule carried a couple of sacks of coarse canvas attached to the pack-saddle. Each sack will contain about 125 pounds of sand and gravel, the mule packing, therefore, 250 pounds, and the train of 16 carrying some 4,000 pounds, or two tons, at one trip.

There being no shafts or tunnels, timbers or pumping and hoisting machinery, the outlay for "mine-expenses" is not quite so great in a black-sand mine as in one of the Comstock mines.

The top gravel being stripped off, the underlying sand was gathered into little piles.

While the men were thus engaged, the superintendent invited Mr. Chase's attention to the appearance of the bed-rock, which glittered with particles, and he could well believe the stories of the first discoverers. So exceedingly fine, however, is the character of the gold that it requires a much larger quantity of these particles to make a cent in value than one not familiar with the subject would suppose. After the sand had been shoveled into little piles, the canvas sacks were taken from the mules and filled. With a word from the driver each mule walked up gravely between his sacks. On their being placed on his back he would start off on a trot for the works. The animals had to pass several points where the sea was breaking pretty well upon the bluff; when they saw a heavy breaker coming in they would face the cliff like veterans, with firmly-braced feet and drooping ears, and allow the water to dash over them. When the swell receded they would start again on their way. During the time Mr. Chase was present these mules made three trips, carrying up over six tons during a single tide.

On arrival at the works the sand is placed in an inclosure called the "sand-corral." A large lagoon near by supplies the water for separation. A small stationary engine and force-pump is in use. The washing is done in "long toms" with copper-plates. The plates are first coated with a layer of silver before the quicksilver is applied. During the week Mr. Chase was in the vicinity of the works they cleaned up a six or seven days' run and retorted $1,600 from the washing of two machines. The succeeding week they cleaned up $1,700. This yield comprised the gold from a portion at least of the rich deposit spoken of.

As the experience of the successive proprietors of this extraordinary gold-mine goes to prove that immediately after a heavy cave or slide of the banks, the beaches are richer and its gold coarser, it seems strange that up to the present time no artificial means have been resorted to in the way of blasting down the cliffs or undermining them by hydraulic process to increase the yield of gold. The sea, working ceaselessly night and day, is the great natural separator, and man has but to gather the results of its tireless work. Many ideas have been advanced as to the possibility of gold in quantities and coarser in character, being found beyond the line of surf; predicated on the fact that it, in conjunction with black sand, has been said to have been brought up from the bottom by the leads of sailing-vessels. Several expeditions have been fitted out from this port to procure this sand by means of diving apparatus, &c., but none of them were successful.

Two or three facts can be taken in conjunction to form an idea on this subject. The first is that the gold evidently comes from the bluffs. This no one can doubt after once viewing them. The second, that after caves the gold obtained is much coarser in character. The third, that it is only after a continued succession of swells that cut the beach at an angle that the rich sands are found. When the surf breaks square on, let the storm be ever so heavy, it simply loads the beaches with gravel. The fourth, that no one witnessing the power of the surf, breaking as it does, with no rocky headlands, points or rocks to deaden it, can doubt that it must have an immense grinding force. From these facts Mr. Chase believes that the gold follows the first two or three lines of breakers, and will never be found in paying quantities beyond.

Mr. Chase sent to Prof. J. D. Dana specimens of the sands of Gold Bluff, and that gentleman, in speaking of the sands, says: "The red grains in the sand are garnets. It is altogether probable that the deposit dates partly from the close of the glacial era; that is, the time of the melting of the ice in the early part of the Champlain Period when floods and gravel depositions were the order of the day, and partly from the later part of the Champlain Period when the floods were but partially abated, yet the depositions were more quiet."

TRINITY COUNTY.

This county lies in the northwestern portion of the State, and until recently has been difficult of access. It has therefore not been as fully noticed in my former reports as its merits as a field for mining operations would warrant. Dr. Henry Degroot visited this portion of the gold-fields of California in the fall of 1873, and has furnished the following description of its situation and rescources:

Trinity County derives its name from the principal river flowing through it, which latter was so called by the first whites who entered the country, under the impression that it emptied into Trinidad Bay, as laid down on the old Spanish charts of the coast. Situate so remote from the great centers of information and business, and, until recently, so difficult of approach, less has been known of this section of country than of any other important mining-district in the State.

Trinity County covers an area of about two thousand five hundred square miles, being a little over eighty miles long, from north to south, and thirty miles wide. The Trinity, Scott, and Salmon River Mountains, with their spurs and outlying ridges, cover almost the whole county. These mountains are composed mainly of granite and gold-bearing slates, many of their foot-hills and lower slopes being made up wholly of auriferous gravel. At numerous points they rise to an elevation of seven or eight thousand feet, the highest peaks being fully 6,000 feet above the level of Weaver Basin, which has an altitude of 2,162 feet. In ordinary seasons, snow lies on the higher portions of these mountains throughout the year. The views obtained here, both in the immediate neighborhood and of the distant mountain-scenery, are very grand. On the road in from Shasta we have two noted peaks standing off a little to the south, the more easterly of these, Shasta Bally, being 6,375, and the other, Yella Bally, 7,641 feet high, while across the Sacramento Valley, one hundred and fifty miles away, Lassen's Peak, flanked by several lofty buttes, lifts itself to a height of more than 10,000 feet. To the north is seen Mount Shasta, still more lofty, and in its vastness appearing close at hand, though more than a hundred miles away. Usually the mountain, a huge cone, is covered with an unbroken sheet of snow for a distance of several thousand feet below its summit.

The Trinity River, which rises in the northeastern part of the county, runs first nearly south, then west, and finally bending round to the north, after pursuing its course in that direction for fifty miles or more, falls into the Klamath. This river has a north and a south fork, the latter having a large arm called the Hay-Fork. The main river is sometimes termed the Middle Fork. These streams, with their numerous tributaries, cut the entire surface of the country into high ridges and deep cañons, nearly all the flat or arable land in the county being confined to some narrow strips along the principal streams. Owing to the elevation of the mountains, the snow, which falls in great depth, is apt to lie for a long time, keeping up the streams, and thus affording water for mining purposes until late in the summer; many of the creeks that head in the higher ranges carry several thousand inches of water throughout the season. In this particular the county is favored beyond most other parts of the State.

Weaverville, the county-seat, is the only town of considerable size. Nearly all the business of the county is transacted at this place, it being connected with the leading mining-camps by means of good pack-trails or wagon-roads, and most of the inhabitants coming here for their supplies. From this point, therefore, most of the gold-dust produced in the country has always been shipped. At one time these shipments were enormous, having, for a while, averaged between four and five million dollars per annum. Lately they have amounted to only about $1,500,000. The total value of the bullion sent out from this place is estimated at $65,000,000, some placing the sum as high as $70,000,000—the whole of it the product of Trinity County.

The topography of the county presents a peculiar system of mountains, streams, and lakes. A glance at a map of this portion of California shows the main Trinity River entering the county at its northeastern corner, whence it flows south until it nearly reaches the edge of the gold-bearing lands, when it curves round, and running toward the northwest passes out of the county. The quantity of water carried by this stream and its numerous confluents varies with the season. Having but little fall, the main stream flows with a moderate current. Its tributaries, however, are all very rapid, some of them having an average descent of more than 200 feet to the mile. All the forks and larger branches of this river are separated from each other by mountain-ridges, their lower slopes composed of slates covered with beds of auriferous gravel, their upper portions consisting wholly of granite. These ridges are lofty, some of them reaching an altitude of more than 8,000 feet. Their upper slopes are precipitous—often mere cliffs of bleached and naked granite. As a general thing, however, they are timbered almost to the top. Their sides are deeply eroded with cañons, which, becoming the receptacles of the drifted snow, hold the water in reserve until late in the summer. At a number of points these mountains spread out into plateaus or basins near their summits. In these depressions occur little lakes, all very deep, and some of them covering several hundred acres. In these lakes many of the larger streams take their rise, and such of them as are suited to the purpose have been secured for reservoirs. By damming up their outlets, which can be done at small expense, their capacities can be increased many fold, insuring steady water to the ditches fed by them nearly the year round. With these bountiful sources of water-supply, and with the gold-bearing material so prolific, plentiful, and favorably situated, we have here the conditions for a large and general success in this branch of mining. Even the most extended ditches will not require to be more than thirty-five or forty miles in length, while in most cases they will need to be not more than half that long. Of the ditches constructed there is scarcely one having a linear extent of twenty-five miles, the majority of them ranging from three to ten miles in length, with water-carrying capacities proportionally restricted.

The auriferous deposits which now constitute the principal basis of mining comprise three classes: the mountain-gulches, the benches and higher bars along the rivers, and the banks or hills of gravel lying farther back between the larger streams and the mountains. The first of these are nearly exhausted; the second class, which yields a large proportion of the gold now gathered, is rich and easily worked, the gravel varying from 20 to 60 feet in depth, being loose, free from large bowlders, and readily run off. Sometimes the water used for washing is raised by means of wheels placed in the river and turned by the currents. Oftener, however, it is brought from the adjacent mountain-ravines through small ditches, the head being always feeble and the supply usually running low before midsummer. These benches are very extensive, reaching along the main river for miles at a stretch, sometimes two or three tiers high, and will afford profitable mining for a great many years. With the exception of providing water, they are attended with but little expense or trouble. The tailings are run into the river, where the accumulations of the season before are swept away with each recurring stage of high water, preventing thereby any permanent collection of waste matter at the discharging end of the sluices. In the third class of deposits, however, the large and enduring wealth of Trinity rests, and it is these that will give to this county prominence as a hydraulic region over every other in the State. Nowhere else has such a depth of pay-gravel been met with as here. In the central and more southerly counties beds having a thickness of 200 or 300 feet are considered remarkable. At all the great hydraulic centers of Placer, Yuba, and Nevada Counties, the average depth is considerably short of 200 feet. This is much less than the ascertained thickness of the deposits of many localities in Trinity County. In some places the depth of gravel is believed to be 600 or 800 feet, and there are points where the absence of bed-rock in the intersecting cañons seems to indicate a still greater depth than this. Along the easterly base of the mountains that separate the North Fork from the main Trinity the cañons cut the gravel-ranges to a depth of 1,500 feet without anywhere disclosing along their sides the bed-rock; numerous shafts sunk on the ridges above to the depth of several hundred feet having also failed to reveal any signs of its presence there.

Another remarkable feature of these deposits consists in their entire freedom from volcanic flows, ashes, or other igneous matter, such as has frequently elsewhere rendered the working of the gravel exceedingly troublesome, and very often wholly impracticable. By the absence here of pipe-clay and sand—the former a difficult stuff to get rid of, and both barren of gold—the miner is relieved of another source of perplexity and hinderance. When it comes to be run off to a lower level than has yet been reached it is possible that the gravel here will occur in a more indurated or cemented form; though as yet nothing so impacted has been encountered as to require the use of powder to break it up. So, also, it may come to pass when washing has been extended to much greater depths that the rim-rock formation will present itself, making the construction of bed-rock tunnels a necessity. As yet these rocky rims of the old river-channels have nowhere been reached.

Another peculiarity of the deep gravel-banks here remains to be noted—so far as explored, they pay all the way down, and improve with depth attained. In all the shafts sunk and pits washed out, no wholly barren strata have been intersected or exposed. A good "prospect" can be obtained everywhere, even upon the surface; a pan of gravel taken from the tops of the hills never fails to give the "color." Vertically measured, every inch in the shafts sunk shows gold—always a number and sometimes many small particles to the pan. The showing made almost anywhere on top of the ground here would be considered a fair shaft "prospect" in most of the old districts, while the dirt removed at considerable depths is often rich enough to pay for drifting.

Only along the deeper ravines and at the few points where they abut on the rivers and larger streams have these high gravel-ranges been much worked. Wherever washing has been done, however, the returns have been liberal and often very large, despite the careless modes of conducting it and the imperfect style of apparatus employed. Only while the water lasts—and that, with their few and inferior ditches, is not long—do the miners think of making any serious exertions. So generously do their claims pay that the most of them are enabled to earn enough during this period to carry them through the year, and generally leave a handsome surplus besides. They have not been in the habit of using either quicksilver, the undercurrent, or any other means for saving the fine gold, which, having been suffered to go off with the tailings, has reduced their earnings considerably below what, with the observance of a little more economy and thrift, they might have been. But all this, under the new order of things about being inaugurated, is likely to meet with early correction.

Most of the miners here own several small claims, and some of them large tracts of mining-ground, often with ditches and water-franchises. Most of these are held on speculation or for sale, and as compared with prices elsewhere the figures set upon them are not extravagant.

These gravel-ranges are everywhere cut at short intervals by deep ravines, through which flow large and rapid streams, fed by the perpetual snows that cover the mountains in which they have their sources. These ravines supply to almost every claim a good working-face and at the same time ample fall and outlet for the escape of tailings. The mountains stand so immediately over the gravel-belts that short and inexpensive ditches suffice to bring water upon the ground to be washed, delivering it generally under a greater head than can with safety or advantage be fully availed of.

Several important projects for utilizing water and working large areas of proven ground are now in progress. Among these is the McGillivary Company's works. This property embraces an extensive and rich area of the terraced bars on the river, a large ditch, with valuable water-franchise, and several hundred acres of rich alluvial land. Atkins & Lowden also own twenty miles of ditch, with a capacious system of reservoirs, insuring a water-supply during the whole year. Other ditches are projected for bringing the waters of Cañon Creek and the North Fork and its tributaries upon Oregon Divide and the benches along the main Trinity, a group of lakes lying under Mount Bally and other tall peaks of the range being used as feeders. The Loveridge Canal, a bold and costly scheme, contemplates the conveyance of a large volume of water across a mountain-gorge more than a thousand feet deep, by means of depressed iron pipes. The Davidson Flume, projected on a larger scale than any other structure of the kind in the State, being 12 feet high and 16 feet wide, is another work of much local interest. This flume has for its object the running off of the water and tailings from the Weaver Basin, and will greatly benefit a large community of miners, besides enriching the owners, should it result in the final accomplishment of the end proposed. Other enterprises are projected looking to the same end, as well as some of minor importance, already well advanced toward completion.

Although placer-mining was commenced here as early as 1849, on the bars of the Trinity River, and has been prosecuted on a small scale since that time, the surface has merely been skimmed over, and the deep placers have not been attacked with the appliances in use in the central portion of the State. A year or two since a number of hydraulic miners, old residents of Placer and Nevada Counties, learning of the good openings presented here for that style of washing, came to Trinity, and having looked about and become satisfied with the appearance of things, proceeded to obtain interest, by purchase and location, in mining-grounds, water-rights, &c., several of them taking up their abode here. These men, with their greater experience and more advanced ideas, were not long in introducing the improved apparatus and modes of operating to which they had been accustomed; and to such an extent has the use of these since obtained, that the product of gold-dust has already been sensibly increased, and every description of mining property is much enhanced in value. To illustrate this point more fully, it may be remarked that eighteen months ago the style of nozzle known as the Little Giant, by far the most effective in use, had not yet made its appearance here; the old-fashioned pipe and, very often, the canvas hose being still employed, while much of the hydraulic washing done consisted simply of ground-sluicing. Now there are over forty of these implements at work in the county, and the number will be more than doubled the present season. Until recently the undercurrent, the most complete gold-saving device yet operated in connection with hydraulic washing, was a stranger here, while the use of quicksilver was almost unknown, not a hundred flasks having as yet ever been consumed in the county. The non-employment of these new aids and inventions, elsewhere deemed indispensable to success, was due not so much to an ignorance of their existence or any great obstacle in the way of their earlier introduction as to the fact that the miners here were able to realize good wages without recourse to this class of auxiliaries. In the high benches along the river and in the deep banks of hydraulic gravel, all found good pay-diggings after the deposits on the low bars and along the gulches had been exhausted. Hence the entire population, aided only by the crude methods and appliances of the earlier day, have been able to earn much higher wages than the average throughout the other mining-districts of the State. For the same reason the construction of more and larger ditches, as well as other works designed to facilitate mining operations, has been neglected.

But all this is about to be changed: with the advent of more experienced and energetic miners, new implements and apparatus have been brought into use, and new enterprises set on foot. The neglected water-franchises, including reservoir-sites, lakes, and running streams, have been taken up and secured. Thousands of acres of auriferous gravel have been located, and much of it patented. Ditches of extra large capacity have been projected, surveyed, and, in some cases, graded and partially excavated. Prospecting shafts have been sunk, roads have been built, and within a single year more than 40,000 feet of heavy iron pipe have been laid down, the whole of this advance having been accomplished in less than one year and a half. And yet the era of progress has but just commenced. For years to come preliminary work must be active here.

The auriferous quartz-veins of Trinity County have received as yet but little development or attention.

Trinity Centre.—Trinity Centre is a small town situated near Trinity River, thirty miles northeast of Weaverville. There is a considerable area of good mining-ground and some excellent farming-land in the neighborhood. The mines in this vicinity have always paid well, and still richly remunerate the six or eight companies, employing some fifty hands, who continue to work them. There are many deep ravines in this section, which afford a good deal of water early in the season, but do not hold out long. This place has received an accession of miners from the older and more central counties, and is likely soon to regain something of its former prestige.

In what is known as the Strope Creek country, located a short distance southwest of Trinity Centre, we find a very active mining locality. This district comprises the region lying along and adjacent to the east branch of Stewart's Fork and its tributaries, of which Coffee, Musquito, Strope, and Digger Creeks are the principal—with Ridgville, near the junction of Digger Creek and the East Branch, for its central mining-camp. The principal property here is that of Fred. Deiner, who has aggregated a sufficient number of claims to cover an area of eleven hundred acres. This ground embraces a number of rich gulches and a considerable extent of deep gravel-banks. The proprietor brings water upon his claims through two short ditches, the one supplied by the East Branch of Stewart's Fork and the other by Strope Creek. These ditches, though small, have, owing to the steepness of their grade, a large capacity, carrying when full about 5,000 inches each. Last fall Mr. Deiner introduced for the first time the Craig "Little Giant," having before operated with the old-fashioned pipe and canvas hose, in the use of which but a comparatively small volume and feeble head of water could be employed. Several smaller claims are being worked here with excellent results, the number of miners employed in the district amounting to about fifty. The ravines in this vicinity have always been noted for their yield of coarse gold. A year or two since a son of Mr. Van Maitre, who occupies a farm at the mouth of Stewart's Fork, picked up a piece of gold near Ridgville worth $2,000. Last fall a ten-pound lump was found in the same neighborhood, and the finding of pieces worth from $300 to $600 and $800 is not infrequent. Only the center of the gulches and ravines here has been washed out, their higher banks and the deep gravel-beds having, as yet, been but slightly exploited. Not a tithe of the gold originally contained in the ground has been taken out. Between Ridgville and Trinity Centre, and even farther up, there are a great many high bars and benches along the river that have been but little worked—some of them scarcely touched—notwithstanding they are known to be rich, and water could easily be brought upon most of them.

Stewart's Fork and its tributaries.—This, next to the main North Fork, is the largest westerly confluent of Trinity River, this stream below its principal branches carrying more than 20,000 inches of water in the spring and early summer. It takes its rise in the main chain of mountains that strikes centrally across the county, its upper sources consisting of several small lakes situated in basin-like depressions near the summit of the range. The streams that lie within the auriferous gravel-belt have yielded large quantities of gold, and although their channels have everywhere been washed out, there are still very extensive hydraulic diggings along them, the gravel-banks that they cut being the deepest in the country. Of the water running in Stewart's Fork and its branches, the Atkins and Lowden Ditch Company have appropriated 10,000 inches, the Loveridge Ditch Company having appropriated from the main fork about 6,000 inches. At its lowest stages this stream furnishes from three to four thousand inches of water. The belt of gold-bearing gravel lying between Stewart's Fork and Rush Creek, the next considerable stream south of it, would appear from the ravines that intersect and the shafts sunk upon it to possess the extraordinary depth of eight or ten hundred feet. It has never been bottomed, however, and it may ultimately prove to be something less than this. This gravel prospects well, and there is no doubt that it would yield munificent returns under hydraulic washing. The Atkins and Lowden Company having completed the survey and grading of a ditch, will commence the work of construction in the coming month of March, it being their intention to have the first seven miles of it completed and the company's ground opened and outfitted early in the summer of 1874. This section, which will not at first be made to the full size, will, when built, bring in the water of Owen's Creek, a tributary of Stewart's Fork, carrying about 2,000 inches. With this the company will be able to thoroughly prospect its ground; and it is believed that it will be possible with the next earnings realized to go on next year and enlarge this section, and build the remaining thirteen miles, constructing the whole on the scale originally projected, 10 feet wide on top, 7½ on the bottom, and 5 feet deep. As the ditch will have a uniform and pretty steep grade all the way, this will give it capacity to carry fully 10,000 inches, a quantity of water that can be commanded from March till August, with nearly half as much during the remainder of the year.

Buckeye Ridge, Boalt's Hill, and Rush Creek.—At a point about six miles south of Stewart's Fork, Rush Creek, a considerable stream, enters the Trinity from the west. The diggings along the stream paid large profits in the early times, and there is still a great deal of rich gravel. But this stream, not heading like most of the other main branches of the Trinity in the high Sierras, has but little fall, and as a consequence is already much filled up with tailings; nor can it be worked to advantage by the hydraulic process until a long tail-flume shall have been constructed for carrying off these accumulations.

Between Stewart's Fork and Rush Creek, abutting on the river and extending five or six miles toward the west, is a vast accumulation of gold-bearing gravel known as Buckeye Ridge. The auriferous material here covers several thousand acres, and has the appearance of being from two or three hundred to a thousand feet in depth. For the few hundred feet that it has been explored by means of shafts, the mass consists of gravel, prospecting well in fine gold. The easterly end of Buckeye Ridge, where it borders on the river, is known as Boalt's Hill, a spot noted for the large amount of gold it has for many years produced and is still turning out. Most of the washing heretofore done has been by ground-sluicing, nothing like a genuine hydraulic apparatus having been placed on the claim.

Lewiston and Grass Valley Creek, and Indian Creek.—Lewiston is a hamlet on the east side of the Trinity, one mile above the mouth of Rush Creek. There is a considerable area of good farming-land in the neighborhood, and this place was once the nucleus of a very prosperous mining-district. There are still a number of claims working, with some wing-damming and river-bed operations carried on along the Trinity, both above and below the town. Grass Valley Creek, a stream coming from the northeast, falls into the river a little below Lewiston. There is a large amount of good pay-gravel along this creek, the principal claim being owned by the Frey Brothers, who have constructed a ditch, commencing some nine miles above their ground, for bringing water upon it. Their claim covers three hundred acres, the gravel, which is rich and easily washed, being from 80 to 125 feet deep. This property has been leased by Atkins & Lowden, who, having fitted it up in good shape, are now running two "Little Giants" upon it. Six miles below Grass Valley Creek, and upon the same side of the river, comes in Indian Creek, carrying in the spring and summer about 2,000 inches of water. Like all these branches of the Trinity, the bed of the stream, invariably rich, has been thoroughly washed out. But there still remain good mines on the higher bars on each side, and extending up the stream for six or eight miles from the mouth.

Weaver Creek.—This stream enters the Trinity from the north, two miles below the foregoing, draining with its two main branches and their tributaries the circular valley known as Weaver Basin. Here, near the center of the basin, six miles from Trinity River, and one mile above the junction of the east and west branches of the creek, is situated Weaverville, the county-seat and center of what was formerly one of the richest mining-districts in the State. Every gulch and stream making into this basin, including the main creek and its branches, abounded in gold. The surface-diggings have been nearly exhausted; but there still remains in this basin a large body of rich gravel, with which little has been done, or ever can be done, until means are devised for effecting its drainage, the natural fall of Weaver Creek, its only outlet, being insufficient to carry off and discharge the tailings into the river. This gravel has been thoroughly prospected, at many points, with excellent results. A shaft was sunk near the head of the basin to a depth of more than 700 feet, without reaching bed-rock. It was carried down in rich gravel, the gold generally being coarse. A number of open pits have been successfully worked to moderate depths, being freed of water with steam-pumps. But no extended system of working has been feasible here, owing to the difficulty of getting rid of the water and tailings; nor can any be introduced until this is accomplished. In the hope of partially effecting this end, a work known as the Davidson flume is now being built along Weaver Creek. This structure, which is to extend from the bottom of the basin to Trinity River, is 16 feet wide and 12 feet high, built in two compartments, the whole having been constructed of massive material and in the most substantial manner, being anchored with strong iron bolts to the bed-rock where laid down in the bed of the creek or otherwise exposed to the fury of the floods. About one mile of the six to be built has been finished; and the entire work will be pushed to completion as soon as possible. It is not expected that this flume will be able to carry off more than a portion of the surface-water and tailings; but this object, if accomplished, will bring relief to a great many claim-owners in the basin, and insure large revenues to the proprietors of the flume, as a great deal of gold must be caught in it, should the fall prove sufficient to run off any considerable amount of this material. The only manner in which this basin can be "bottomed" is by means of a tunnel extending from it west and opening on Oregon Gulch or Trinity River, at a point some five or six miles distant; a work already in contemplation. There is still a good deal of surface-washing going on in this basin and along the creek, water being supplied chiefly from what are known as the East and the West Weaver ditches.

Below Weaver Creek we have the following streams (omitting those of less magnitude) coming into the main Trinity from the south and west, viz: Reading's, Brown's, Maxwell's, Soldier, Sturtevant, McKinney, and O'Conner Creeks. During the spring and early summer they carry from two to three thousand inches of water each, have a great fall and much good mining-ground along their banks, though the beds of the streams were long since worked out. On the bar at the mouth of the creek, both of which still bear his name, the old pioneer, Reading, took out large quantities of gold in the summer and fall of 1849. He was the first white man in the country and had fifty or sixty Indians in his employ. Three or four small companies are at work on this creek. Most of the water used here is obtained from Paulson and Christenson's ditch, which carries about 1,000 inches, taken out of the creek five miles above its mouth.

Although there are some excellent gravel-banks along Brown's Creek, but little work is being done here. Not half the water running in this creek, which carries, at its fullest, nearly 2,000 inches, has been brought into use. A small ditch takes a portion of it to the river, across which it is passed through a flume suspended from wire cables and used on the opposite side.

From Brown's to Maxwell's Creek the river runs in a steep cañon, leaving little chance for the formation of bars. Maxwell's Creek holds a good "pipe-head" of water till the 1st of July and about one-fourth as much for the remainder of the year. There is but little mining done along it, though there are some fine bars on the river, upon which a small ditch carries water, taken from the creek three miles above its mouth.

On Soldier's Creek Fisher & Co. have fitted up a set of hydraulic claims in good style, supplying them with two of Craig's "Little Giants" and other modern improvements. As they use nearly all the water afforded by this creek there is but little other washing carried on along it.

Sturtevant Creek affords about 1,000 inches of water, which is mostly used on Keno Flat, where there are some first-class claims.

McKinney Creek gives only about enough water for two or three sluice-heads till June. This is employed on the McKinney claim, a very rich piece of ground, but limited in production by the want of water.

O'Conner Creek is a large stream, reaching the river at a locality known as the Red Hill country, consisting of two tiers of extensive benches, noted for the blood-red color of the gravel they contain. A good deal of gold-dust is washed out here every season, the water being supplied by O'Conner Creek.

Several miles farther down and a little below McGillivray's Ranch a small and nameless creek enters the river. At its mouth lies a low rich bar upon which a company of Germans are making good wages stripping off the top-dirt and wheeling up the gravel and washing it in sluices, water for the purpose being raised by means of a large, wheel. A little below this point a steep cañon sets in, preventing the formation of bars along the river for several miles. Mining operations below this are less active and occur at longer intervals.

On the northerly and easterly sides of the river several important mining localities remain to be noticed. The McGillivray claims, already alluded to, are now being extensively and profitably worked. The water here is mostly obtained from Cañon Creek, a large stream flowing into the Trinity from the north. On reaching the river it is conducted across through a massive iron pipe resting on wire cables. The ditch constitutes a part of the property, which is a very valuable one, having for many years returned the owner large net profits.

Along both Cañon Creek and the North Fork of the Trinity, which enters the main river a little below McGillivray's, there still remains a large extent of good diggings, not one-quarter of the water at command here ever having been brought into use. During the past year, however, all the unclaimed water, a very large amount, has been taken up by Capt. George H. Atkins and his associates, who have already surveyed and commenced work upon a system of extensive ditches and reservoirs, designed to utilize the supply in an effective manner, it being their intention to supply an aggregate of 20,000 inches to the mines along these streams, as well as the main Trinity and the westerly slopes of Oregon Ridge—the latter an immense field of rich gold-bearing gravel.

CHAPTER II.

NEVADA.

The great increase in the product of gold and silver (principally silver) from this State is chiefly due to the extraordinary developments on the Comstock lode, and to the activity on a large scale of the smelting-works at Eureka. The total product is given by Mr. Valentine as $35,254,507, an estimate which is to be accepted as the best that can be made, though in the item of the value of ores shipped out of the State for treatment it is perhaps somewhat under the truth.

Detailed accounts from the various mining-districts will be found below. I introduce in this place statistics prepared by the county auditors and assessors, and covering the year ending June 30, 1873.

Abstract statement from the quarterly assessment-rolls of the proceeds of the mines of the several counties of the State for the quarter ending September 30, 1872.

Counties.	Quantity extracted.		Average value.	Gross yield.	Net yield or value upon which taxes are levied.	Total tax.	State tax.	County tax.
	Tons.	*Lbs.*						
Elko, ores	1,471	......	$56 74	$83,463 00	$33,659 20	$1,144 41	$420 74	$723 67
Humboldt, ores	2,556	1,741	35 26	90,179 09	26,926 05	713 53	336 57	376 96
Lander, ores	14,627	2	49 81	728,671 95	276,417 51	9,331 56	3,455 22	5,876 34
Lincoln, ores	12,916	1,075	107 91	1,398,907 25	796,039 22	28,259 39	9,950 49	18,308 90
Nye, ores	573	502	168 61	96,637 76	38,253 99	1,124 12	478 17	745 95
Storey, ores	99,637	......	27 65	2,755,658 94	1,004,126 33	15,061 88	12,551 58	2,510 30
White Pine	7,861	930	33 32	961,806 00	88,589 80	2,923 46	1,107 37	1,816 09
Elko, tailings	835	......	5 58	4,656 70	465 87	15 84	5 82	10 02
Humboldt, tailings	2,150	......	10 31	22,176 35	2,217 63	58 77	27 72	31 05
Lincoln, tailings	904	1,509	19 64	17,770 91	4,569 20	162 91	57 37	105 54
Lyon, tailings	71,355	......	2 97	212,509 34	30,608 46	918 25	382 61	535 64
Storey, tailings	1,884	......	4 50	8,478 00	4,710 00	70 66	58 87	11 79
Washoe, tailings	3,576	......	5 76	20,610 00	5,591 00	181 71	69 88	111 83
Total	220,347	1,819		5,701,527 49	2,312,194 26	60,066 49	28,902 41	31,164 08

Abstract statement from the quarterly assessment-rolls of the proceeds of the mines of the several counties of the State for the quarter ending December 31, 1872.

Counties.	Quantity extracted.		Average value.	Gross yield or value.	Net yield or value upon which taxes are levied.	Total tax.	State tax, $1.25	County tax.
	Tons.	*Lbs.*						
Elko, ores	3,181	......	$41 71	$132,672 99	$50,855 15	$1,729 07	$635 69	$1,093 38
Esmeralda, ores	459	1,000	89 35	41,057 05	11,463 30	401 19	143 29	257 90
Humboldt, ores	2,605	1,670	37 77	98,422 58	24,419 93	647 14	305 25	341 89
Lander, ores	18,265	132	48 65	888,708 58	128,419 08	4,297 00	1,605 24	2,691 76
Lincoln, ores	14,728	447	95 95	1,406,228 59	689,848 48	24,136 92	8,623 10	15,513 82
Nye, ores	653	1,572	91 25	59,600 45	21,509 70	688 31	268 86	419 45
Storey, ores	90,951	1,450	31 32	2,899,021 60	1,310,830 90	19,512 46	16,260 39	3,252 07
White Pine, ores	2,931	910	34 97	102,528 28	37,745 02	1,245 57	471 81	773 76
Humboldt, tailings	4,290	......	7 35	31,536 00	3,468 40	91 90	43 35	48 55
Lincoln, tailings	1,690	1,200	23 80	38,554 68	7,710 91	273 73	96 39	177 34
Lyon, tailings	52,541	......	3 18	167,385 64	24,227 69	726 83	302 85	423 98
Storey, tailings	14,400	......	9 84	141,743 31	16,274 32	243 81	203 43	40 38
Washoe, tailings	3,531	......	4 83	17,051 05	1,851 05	60 15	23 14	37 01
White Pine, tailings	1,900	......	3 30	6,270 00	1,123 60	37 08	14 05	23 03
Total	212,129	381	....	6,032,840 80	2,312,747 53	54,091 16	28,996 84	25,094 32

Abstract statement from the quarterly assessment-rolls of the proceeds of the mines in the several counties of the State for the quarter ending March 31, 1873.

Counties.	Quantity extracted.		Average value.	Gross yield.	Net yield.	Total tax.	State tax.	County tax.
	Tons.	*Lbs.*						
Elko, ores	1,685	......	$28 93	$46,979 43	$9,785 88	$332 72	$122 32	$210 40
Esmeralda, ores	685	1,000	103 13	70,697 41	23,387 51	818 55	292 34	526 21
Humboldt, ores	1,657	1,400	31 96	53,992 00	13,543 50	406 30	169 29	237 01
Lincoln, ores	14,799	667	72 63	1,074,392 05	453,639 94	18,145 48	5,670 50	12,474 98
Lander, ores	1,284	612	148 24	190,607 63	28,402 37	2,430 95	1,105 29	1,325 66
Nye, ores	653	1,562	90 48	50,000 45	21,504 70	688 31	268 86	419 45
Storey, ores	110,085	......	45 91	5,054,903 02	3,074,287 71	46,114 31	38,428 60	7,685 71
White Pine, ores	1,051	1,640	31 67	33,425 35	12,263 23	429 21	153 29	275 92
Humboldt, tailings	3,560	......	8 21	29,249 00	4,774 00	143 22	53 71	89 51
Lincoln, tailings	1,606	......	17 11	27,491 65	5,390 80	205 62	67 38	143 24
Lyon, tailings	38,824	......	3 25	129,984 58	17,618 64	563 79	220 23	343 56
Storey, tailings	6,399	......	10 95	70,105 33	8,222 23	193 33	102 78	90 55
White Pine, tailings	5,000	......	1 00	5,000 00	5,000 00	175 00	62 50	112 50
Washoe, tailings	2,787	......	5 29	14,446 93	2,000 23	65 00	25 00	40 00
Total	190,951	891	....	6,700,934 73	3,739,825 83	70,651 79	46,742 09	23,909 70

Abstract statement from the quarterly assessment-rolls of the proceeds of the mines of the different counties of the State for the quarter ending June 30, 1873.

Counties.	Quantity extracted.		Average value.	Gross yield or value.	Net yield.	Total tax.	State tax.	County tax.
	Tons.	*Lbs.*						
Eureka, ores	17,619	911	$38 70	$684,913 84	$138,300 10	$4,219 98	$1,729 50	$2,490 48
Esmeralda, ores	1,204	......	74 52	89,747 22	19.564 40	684 76	244 55	440 21
Nye, ores	3,301	1,561	81 53	277,551 35	90,903 09	2,897 19	1,248 79	1,648 40
Lander, ores	1,660	368	155 37	257,942 06	123,354 05	3,392 23	1,541 92	1,850 31
White Pine, ores	4,603	119	39 94	178,832 00	67,900 00	2,376 50	848 75	1,527 75
Storey, ores	119,440	110	57 20	6,832,815 52	411,876 97	70,178 16	50,148 46	10,029 70
Storey, tailings	14,040	......	7 93	111,403 23	12,410 32	186 15	155 13	31 02
Lincoln, ores	17,452	1,258	61 23	1,069,652 76	425,113 90	17,004 54	5,313 92	11,690 62
Lincoln, tailings	2,611	......	15 02	39,230 53	7,474 63	299 00	93 43	205 57
Elko, ores	1,627	1,000	63 06	102,534 60	49,743 75	1,790 75	621 79	1,168 96
Elko, tailings	252	......	11 11	2,800 00	532 00	19 15	6 65	12 50
Humboldt, ores	3,124	1,500	25 21	78,707 64	24,721 47	741 64	309 02	432 02
Humboldt, tailings	3,080	......	7 21	22,230 00	2,233 00	66 99	27 91	39 08
Lyon, tailings	47,968	......	5 53	265,476 74	30,651 26	1,268 85	495 64	773 21
Washoe, tailings	3,677	......	5 48	20,184 30	3,500 00	115 50	43 75	71 75
Total	241,751	827	....	10,034,081 79	582,633 34	95,247 39	62,829 21	32,412 18

Summary showing the results for the year commencing July 1, 1872, *and ending June* 30, 1873

Counties.	Quantity extracted.		Gross yield.	Net yield or value upon which taxes are levied.	State tax.	County tax.
ORES.	*Tons.*	*Lbs.*				
Elko	7,904	1,000	$335,650 02	$144,043 38	$1,800 54	$3,196 41
Esmeralda	2,349	....	201,501 62	54,415 21	680 18	1,224 32
Eureka*	17,619	911	684,913 84	138,300 10	1,729 50	2,490 48
Humboldt	9,945	311	321,269 29	92,610 95	1,157 63	1,388 48
Lander	35,836	1,114	2,065,930 22	616,503 01	7,707 41	10,754 07
Lincoln	57,889	1,447	4,951,180 65	2,364,641 54	29,558 01	57,990 32
Nye	5,272	1,217	493,910 01	181,176 48	2,264 68	2,233 25
Storey †	420,113	1,500	17,542,399 08	9,391,121 91	117,389 03	23,477 78
White Pine	16,437	1,499	576,501 63	206,408 05	2,581 22	4,393 52
Total	503,388	1,059	27,173,338 42	13,189,460 63	164,868 36	107,146 63
TAILINGS.						
Elko	1,067	....	4,758 70	997 87	12 47	22 52
Humboldt	13,080	....	105,191 35	12,693 03	158 69	208 19
Lincoln	6,812	769	123,048 77	25,165 63	314 57	636 69
Lyon	211,698	....	775,356 50	112,106 05	1,401 33	2,076 39
Storey	36,723	....	331,729 89	31,616 87	395 21	103 94
Washoe	13,511	....	72,292 28	13,942 28	174 27	148 76
White Pine	6,900	....	11,270 00	6,123 60	76 55	247 36
Total	289,801	769	1,426,374 29	202,645 33	2,533 69	3,443 55
RECAPITULATION.						
Ores	503,388	1,059	27,173,338 42	13,189,460 63	164,868 36	107,146 63
Tailings	289,801	769	1,426,347 29	202,645 33	2,533 69	3,443 55
Total	883,189	1,828	28,599,685 91	13,392,105 96	167,402 05	110,589 18

* Created March 20, 1873. † State tax, $1.25; county tax, 25 cents.

THE COMSTOCK MINES.

I have again to acknowledge my obligations for clear and trustworthy notes on the development of these important mines, to Mr. C. A. Luckhardt, now of the Nevada Metallurgical Works at San Francisco, to whose ability I have had occasion, in former reports, to bear repeated testimony. Mr. Luckhardt visited Virginia City at my request, and his intimate acquaintance with the history of each of the mines lends weight to his conclusions regarding them. But for the delay which has attended the annual publication of these reports, the public attention would ere now have been arrested by the striking fulfillment of some of the predictions in which I have ventured to indulge concerning the Comstock lode, and for all of which I have had, besides my own opinion, the better authority of Mr. Luckhardt's judgment.

During the year 1873 only one new development of note was made in connection with the so-often described bodies of ore already explored on the Comstock. It is therefore unnecessary to recapitulate in detail the occurrence of these bodies, for which the reader is referred to former reports.

During the past year extensive explorations have been carried on under the stimulus of the developments made in the southern portion of the Comstock. Following again the method of description heretofore adopted, I commence at the north end of the lode and proceed southward.

I. *The northern portion of the vein.*—The 12,200 linear feet from the Utah to the Chollar have developed, during the year, as follows:

1. The ore-body of the Sierra Nevada was found to extend north into the Utah mine, and has been explored to the vertical depth of 400 feet, showing the same ore as the Sierra Nevada, worth from $3 to $18 per ton, (principally gold.)

The Sierra Nevada has been at work on the same body. The mill being situated at the mine facilitates operations. No new developments have been made.

2. The Ophir Company has carried on explorations from the shaft eastward and southward from the 1,400-foot level principally, showing the vein to be over 300 feet wide. The quartz-stringers and their intersections of quartzose material, intermixed with porphyry, described in last year's report, gave sufficient inducement to carry on explorations southward; and the result was that about 40 feet north of the Ophir south line, the apex of what seems to be a new ore-body has been discovered. The ore, in its character, is similar to that found near the surface in former days, in the old central incline, at the vertical depth of 400 feet, varying entirely from that ore which constituted the "third ore-body" of my former reports. Its dip is apparently 70° east, and its pitch is decidedly southward. Sufficient explorations have not as yet been made to permit speculation with any degree of certainty as to its merit.

3. The ground adjoining the Ophir to the south, as far as the Best and Belcher, known as the Virginia Consolidated, (excluding the Central ground,) has been divided into two distinct companies. The northern portion of the Virginia Consolidated, including the Central, California, and Central No. 2, is now known as the California Consolidated. The ground south of this, to the Best and Belcher, constitutes the Virginia Consolidated. The developments made through the 1,465-foot level of the Ophir promises well for the California Consolidated Company's ground; and explorations are carried on through the Ophir Company's ground to investigate it.

4. The developments described in last year's report in the 1,400 linear feet extending from the Central to the Gould and Curry, made by the Virginia Consolidated Company on its 1,167-foot level, and constituting at that time already a noteworthy feature, have since led to the ex-

posure of an ore-body now fully 300 feet in length, and varying from 8 to 30 feet in width, of $45 mill-ore. The connection between this level and the Virginia Consolidated shaft has been completed, facilitating the work of the latter company materially as compared with last year, when all the explorations had to be done through the Gould and Curry. The ore of this body is identical with that of what was known as the East Potosi chimney of the Savage. It carries much argillaceous matter, but is not sufficiently near the eastern boundaries of the vein to be referred to the Potosi chimney of the Savage; on the contrary, it has every appearance of constituting an independent ore-body of large dimensions. For the past six months the Virginia Consolidated has extracted an aggregate of 50 tons per day of the above-named value from it. From all appearances this body will extend much farther south than it has as yet been developed.

5. The Gould and Curry has not made any new developments during the year, but there are hopes of meeting the above ore-body on the 1,300-foot level, where explorations are now being carried on both northward and eastward.

The Savage has been worked on its 1,400, 1,500, 1,600, 1,700, and 1,900 foot levels, and the vein has been explored to the south line in all of them. With the exception of the 1,300-foot level, no work has been done north of the company's shaft. The 1,400-foot level developed, south of the shaft, a large mass of quartz with small ore-seams, but not in sufficient quantities to warrant extraction.

The ore-body of last year's report encountered on the 12th or 1,500-foot level has been exhausted, and no ore has been extracted since April, 1873. The incline has reached a depth of 60 feet below the 1,900-foot level, at an angle of 38° east.

6. The Hale & Norcross has not made any new developments of note during the past year. The 1,400-foot level south of the shaft showed some quartz and ore resembling the tributaries of the ore-body of the sixth and seventh levels, which has been exhausted.

During the year explorations have been carried on by various companies east of the Norcross and Chollar Companies' grounds, but without success in finding anything of note. The Senator, at a depth of 400 feet, exposed the feldspathic porphyry of the Sierra Nevada 800-foot level, barren of quartz. The Julia, situated east of the Chollar, exposed, at a depth of 1,100 feet west of its shaft, some quartzose material carrying silver, but not in paying quantities.

III. *The middle portion of the vein*, including Chollar, Bullion, Exchequer, Alpha, Imperial, and Empire, &c., an aggregate of 1,800 linear feet, has not shown any new and noteworthy developments during the past year.

1. The Chollar has been at work on the apparently inexhaustible mass of ore of low grade at and near the surface, and is still extracting from 60 to 70 tons per day of $20 to $25 mill-ore. No new discoveries have been made through the east shaft. The explorations northward in the 725-foot level showed that the body of the Hale & Norcross did not extent as far south as was expected.

2. The Bullion 1,400-foot level, with east drift, did not give encouragement for further explorations. The quartz encountered varied from 20 to 40 feet in width in places carrying small ore-seams, carrying as much as several hundred dollars per ton in silver, but not in quantities for extraction. The workings of this company are apparently too far to the west to encounter ore in quantity.

3. The Imperial 1,400-foot level showed the vein wider than in the three

levels immediately above, carrying in places 60 feet width of quartz, with small bunches or ore, but of no value.

II. *The southern portion of the vein*, from the Imperial to the Overmann, does not show, outside of the Belcher and Crown Point ore-body, any new developments.

1. The Yellow Jacket has reached a depth of 1,630 feet. Explorations have been carried on in the 1,300 and 1,400 foot levels through the quartz-body described in last year's report, but without finding anything of note. Small quantities of ore have been extracted from the upper levels. The Kentuck connected Crown Point and Jacket on the 1,500-foot level through that massive quartz-body which the Jacket developed, but without meeting with ore.

2. The developments in Crown Point are described in the official report below. From another source it is reported that the ore runs from 250 to 300 feet north from the south line, about the same on all the levels worked, viz, from the 1,100 to the 1,500 foot level. Cross-cuts east, near the Kentuck south line, show a heavy quartz-body, but no ore.

3. Belcher has attained a depth of 1,460 feet. The appearance of the mine has changed but little from what it was last year. The average length of the ore-body is 320 feet, and its width may be put at fully 40 feet. The most southerly point of the ore-body yet reached is 400 feet from the company's north line on the 1,300-foot level. The average value of the ore is $65 per ton; the daily product 550 tons; and the value of the bullion $2.57 per ounce. The ore-body is of such dimensions that it is even as yet impossible to come to any definite conclusion as to the locality of its center or the direction of its axis; but, from all appearances, its inclination is northward.

4. The Overmann has attained a depth of 900 feet in the new shaft, which lies 1,500 feet east of the company's old works. At depths of 700 and 900 feet, levels have been run west of the shaft, and, about 200 feet north from the company's line, some favorable indications were met with. The quartz resembles that of the Belcher ore-body, and its position is south 5° west from the ore-body in the 1,000-foot level of the Belcher; but the development does not fully justify the expectation of finding ore in paying quantities in the immediate vicinity.

5. Following the western branch of the Comstock (if I may so speak) toward American Flat, quite extensive explorations have been carried on in the various mines, from the Caledonia south and west, all of which show the existence of the quartz and low-grade ore which constituted the long-ago exhausted western ore-bodies of the Overmann and Uncle Sam, &c., carrying at intervals seams and bunches of rich ore of insignificant dimensions. Nothing important has, however, been exposed during the past year.

6. In the ground southeastward from the Overmann, toward Silver City, many long-abandoned mines resumed work during the year, and some of them developed bodies of ore resembling that described in last year's report as extending to the Lucerne. Ore-bodies, from which considerable quantities of ore have been extracted, have led to the resumption of work as far south as Cold Spring Valley. One of the most notable developments here was made by the Dayton Company, in lower Silver City, which shows at the present time an aggregate of 300 feet ore length, (in detached bodies,) about 5½ feet in average width, varying from $20 to $100 in value per ton.

The remarks made in my last year's report relative to the favorable appearance of the Comstock mines, and the great probability that more careful and thorough explorations will expose workable ore-bodies in ground already passed through, but insufficiently prospected, might be repeated here. They have not lost their applicability, either for encouragement or for warning. Indeed, in the latter respect they have gained force with time. I do not doubt that the present year, while it cannot exhaust the great ore-body from which the Crown Point and Belcher have obtained so much profit, and the proprietors of other mines so much hope, will nevertheless reveal more clearly than they are now known the limits of that body or of its richest mass. Whoever believes that these mines have now at last entered upon a solid and continuous body, extending indefinitely in depth, and precluding for the future the necessity of explorations, will find himself mistaken.

The Sutro tunnel.—This enterprise has been in progress during the year; and considering the number and variety of obstacles interposed by nature and man, the degree of success so far achieved is creditable to Mr. Sutro and his engineers. The connection established on the 27th October by the meeting of the east and west drifts between shaft No. 1 and the mouth of the tunnel, 4,885 feet distant, was effected with a surprising degree of accuracy. The following account is condensed from the Gold Hill News of October 13 and October 28:

Very few people, even professional men, are aware of the immense difficulties to be overcome in regard to projecting the lines from the surface down to the bottom of the shaft, from whence they have to be continued both east and west, in order to make an accurate connection of the several drifts on the line of the tunnel. The header, it will be remembered, was started from the mouth of the tunnel, in the town of Sutro, and is being pushed rapidly ahead in the direction of Mount Davidson. The drift is being run in a perfectly straight line, rising westerly with a grade of 2 inches to every 100 feet.

Shaft No. 1 is located 21 feet 9 inches off the center line, in a northerly direction, and is distant from the mouth of the tunnel 4,885 feet. In order to start a drift from the bottom of shaft No. 1, to meet the header coming from the town of Sutro, it was found necessary to first run back 21 feet 9 inches in a southerly direction from the bottom of the shaft, until the center-line of the tunnel was reached, thence to turn a right angle eastwardly, and run in this course until the header is met. In order to effect an exact connection between header and shaft, extreme accuracy was necessary in surveying these lines. A serious embarrassment to correct surveying originated from the placing of a boiler on the surface, just at the point where the line of the tunnel crosses the offset line of the shaft, so as to prevent placing the instrument over this very important point. It, therefore, became necessary to lay off the rectangular offset-lines in front of the boiler past the shaft, thence to measure with offset, so as to get a parallel line over the top of the shaft, and from this parallel line to plumb down to the bottom of the shaft 523 feet 8 inches in depth; thence to take this line at the bottom, and prolong it southerly 21 feet 9 inches to the center line of the tunnel, and from this point turn a right angle and start the east and west drifts. From the above-mentioned statement it will be seen that the difficulties encountered in making the survey were much greater than those connected with the Hoosac tunnel, the shaft of the latter being exactly on a line of the tunnel itself. The longest diameter of the Hoosac shaft is 27 feet, and is placed in the line of the tunnel, so that this line could be projected directly in the line of the tunnel, and then be prolonged both ways. The longest base-line that could be projected down the Sutro tunnel shaft was 6 feet 8 inches in length, provided that one plumb-bob is hung down the pump-shaft, while the other is hanging down in the hoist-shaft; but the pump-shaft is almost entirely filled with steam-pipe, exhaust-pipe, plumb-column and its braces, and a ladder-way. Plumbing down the shaft was not considered reliable, as the wire might touch at some point or another; the shaft, also, being so hot from the exhaust-steam as to prevent an inspection of the plumb-bob, therefore the hoist shaft, giving a base-line of 3 feet 1 inch in length, had to be depended upon for projecting the line of the tunnel down in the bottom of the shaft. The slightest variation made, even on the surface, in this short base-line, would result disastrously in throwing the east drift a long way off the true line.

Appreciating the difficulties previously enumerated, the Sutro Tunnel Company cast about for a civil engineer equal to the emergency, and eventually were fortunate enough to enlist in the enterprise Mr. H. Schussler, chief engineer of the Spring Valley Water Company, and still later of the Virginia and Gold Hill Water Company. Mr. Schussler entered upon his work with his usual energy and ardor. Under his careful and accurate surveying the drifts have been run straight as an arrow. He has been ably assisted by Ross E. Browne, a young engineer of marked ability.* The driving of the tunnel is being prosecuted with the greatest vigor. Our reporter rode into the tunnel nearly a mile on a back-action car, an ill-natured mule being the propelling power. When the two headers were 102 feet apart the blasting and drill-hammering could be distinctly heard in the respective faces.

On the Saturday previous a dispatch was sent to the president in San Francisco, to leave there for Virginia on Sunday morning, and thus this gentleman, with a party of others interested in the enterprise, arrived at the tunnel just in time to witness the great event.

Early in the morning, on Monday, Mr. Schussler sent his old chain-man, John Higgins, (who has followed his footsteps for ten years and helped to make five tunnel connections during that time,) over to shaft No. 1 to measure the progress made since Saturday morning. He came back in breathless haste and reported that the rock had, during the last forty-eight hours, turned softer, and that a progress of about four feet more than was anticipated had been made. Upon hearing this unexpected but favorable news, Mr. Schussler exclaimed excitedly, "They are within three feet of one another." He called young Ross Browne, his assistant, and both rushed into the tunnel up to the face of the header. Fifteen minutes after their arrival, a cartridge of giant powder being placed in a drill-hole in the center of the face and ignited, blew a hole about ten inches square through the remaining barrier of rock.

The excitement caused by this event was intense, and the shifts of miners and foremen who were gathered in their respective faces, gave vent to their joy in an unearthly yell that made the old mountain ring; at the same time Schussler, Browne, and Jackson, the foreman, rushed forward and shook hands through the opening, with Mr. De Noon, the mining superintendent of the company, Mr. Brew, foreman at shaft No. 1, and all the boys on the shift. Enough rock was then knocked off with a pick to enlarge the aperture sufficiently to allow the men to crawl through from one drift to the other. The draught through the opening at the time was almost strong enough to force a man through it into the opposite drift. Mr. Schussler received the warm congratulations of the party upon the success of the undertaking, and requested them to delay a few moments to witness any discrepancies which might have occurred in his survey. The instruments were placed in position, and fore and back sights taken through the opening, and to the great astonishment of everybody the difference in his survey between the opposite drifts amounted to only one-half inch in the level and seven-eighths of an inch in the line!

The splendid accuracy of this connection contrasts forcibly with the style of work in some of the leading mines of the Comstock lode. Even at this late day, I am told, there is an alleged error in the determination of the boundary between Crown Point and Belcher, involving the ownership of many thousand dollars' worth of ore.

Into the merits of the debate between the Sutro Tunnel Company and the companies now operating on the Comstock, I have never deemed it proper to enter, in my official reports. From an engineering standpoint, I have always advocated the construction of a deep adit, which is, in my opinion, a necessary adjunct to safe, economical, and permanently successful mining on this lode. I can only regret that the inevitable expense and difficulty of such an undertaking are so greatly enhanced by quarrels about contracts, titles, and royalties; and I trust the work will not be defeated by these conflicts. The following agreement, entered into by some or all of the companies named, in January, 1874, indicates their determination to continue hostilities:

It is hereby agreed by the undersigned, mining companies owning mines upon the Comstock lode, in Storey County, State of Nevada, that they will, and hereby do, jointly employ R. S. Messick, of Virginia City, and C. J. Hillyer, of Washington, as their attorneys at law, to institute and carry to a final decision, under the direction of the committee hereinafter provided for, such legal proceedings as may be necessary to secure a final judgment denying the validity and estopping the enforcement of the claim wrongfully preferred by the Sutro Tunnel Company to a royalty of $2 per ton upon the ore raised from the mines of said companies, or any claim upon the part of said Tunnel Company to charge said mines in any manner other than in accordance with the terms and stipulations of contract made or to be made between it and the mining companies respectively.

J. C. Flood, R. T. Morrow, J. D. Fry, Benjamin Peart, and J. L. Requa are hereby appointed a committee to manage said litigation, and from the fund hereinafter provided for to defray the expenses of the same, including the fees of said attorneys, and of such other attorneys as, upon the approval of said Messick and Hillyer, the committee may deem it advisable to employ.

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*Son of Hon. J. Ross Browne, late minister to China and formerly Commissioner of Mining Statistics.

The first meeting of said committee shall be held upon a call by a majority of its members, and it shall organize by the election from its members of a president and a treasurer and by the appointment of a secretary. All subsequent meetings shall be held upon an order by the president or by a majority of the committee. The committee shall have power to fill vacancies occurring in its own membership, and a majority of the committee shall constitute a quorum for the transaction of all business.

For the purpose of defraying the expenses of said litigation, the said committee are hereby empowered to levy by resolution assessments from time to time, as may by it be deemed necessary, upon each of the undersigned companies, provided that each assessment shall be levied upon all the companies at the same time, and provided, further, that the total amount of all the assessments levied shall not exceed for each of said companies, respectively, the amount herein set opposite the names of said companies, to wit:

Name.	Amount.
Alpha Consolidated	$1,200
Bacon Mill and Mining Company	80
Best and Belcher	2,188
Belcher Silver Mining Company	43,680
Bullion	2,500
Caledonia	2,000
Central	1,080
Chollar Potosi Mining Company	7,000
Confidence Silver Mining Company	1,000
Consolidated Virginia	39,960
Consolidated Gold Hill Quartz Mill and Mining Company	213
Crown Point	48,000
Empire Mill and Mining Company	250
Exchequer	800
Gould and Curry	4,500
Hale and Norcross	3,600
Imperial Silver Mining Company	2,500
Kentuck	2,250
Ophir Silver Mining Company	8,316
Overmann Silver Mining Company	9,600
Savage Mining Company	5,680
Segregated Belcher Mining Company	2,500
Sierra Nevada Mining Company	2,000
Yellow Jacket Mining Company	7,683
Challenge Consolidated Mining Company	750
Eclipse, Winter, and Plato Consolidated Mining Company	750
Central	1,500
French Gold Hill Mining Company	....
	201,580

And provided further, that the assessments shall only be levied at such times and in such amounts as shall be needed to defray the legitimate expenses of such litigation, and that the aggregate amount of each assessment shall be apportioned between the said companies substantially (omitting small fractions) in the proportion of the amounts above placed opposite the names of the companies.

Each of the undersigned companies agrees to pay to the treasurer of said committee the amount of each assessment levied upon it as above provided within thirty days from the time of receiving from the secretary of said committee written notice of the levying of said assessment.

Each of the said companies further agrees to permit the use of its name as plaintiff in any suit or legal proceeding which said committee shall deem it advisable to commence for effecting the purpose above stated, and that its name shall not be withdrawn without the consent of said committee, provided that the entire expenses of such suit or proceedings shall be paid by said committee from the fund above provided for, and that the committee shall have the entire direction and management of the same.

At the meeting of the Ophir Company, January 12, 1874, from the report of which the foregoing version is taken, it was unanimously resolved that the president and secretary of the company be authorized and directed to make and execute, in the name of the company, a contract or agreement, in accordance with the foregoing instrument, binding the company, in connection with other companies on the Comstock lode, to litigate the claim of the Sutro Tunnel Company to collect a royalty upon ores raised from mines of said companies on said Comstock lode.

The following are the statistics officially furnished by the leading companies on the Comstock lode:

Report of the Gould and Curry for the year ending November 30, 1873.

The president, Mr. J. C. Flood, reports that though operations in the mine have been prosecuted without interruption during the past year, no pay body of ore has been developed, so that to provide for current expenses and to meet outlays for such improvements as were required, recourse has necessarily been had to assessments. The future of the mine, at this time, appears promising. The various drifts in the lower levels have established the existence of a defined ledge carrying metal, although in small quantities. This, and the fact of the development of an extensive body of ore in an adjoining mine, warrant the continuance of prospecting operations with increased energy, in confidence that such perseverance will be amply rewarded.

The superintendent reports as follows:

On the second station (425-foot) level the old drifts were re-opened and retimbered to the southward and westward of the shaft. The total length of tunnels thus repaired is 810 feet. Drifts were made to the south and east of the main drift for a distance of 255 feet, and another drift was also run 142 feet to the west, passing through vein-matter and ore of a low grade. A winze was sunk in the vein from this level to the fourth station (625-foot) level below. Several drifts were run in different directions through quartz and porphyry at a depth of 100 feet below this level, which have also failed to disclose any ore of value. On the fourth station (625-foot) level, the old drifts were re-opened and retimbered anew for a distance of 690 feet in a southerly direction. Near the south line a drift was carried east from the main south drift for a length of 140 feet, passing through the Potosi vein. The ore in this locality, as well as on the level above, is of great extent, but is of too low a grade to warrant its extraction. While prosecuting the explorations at and above this level, 2,928.1240 tons of ore of a moderate grade were extracted; but the yield proving too low to pay the expenses of mining and milling it, the extraction of the same was discontinued. On the eighth station (1,300-foot) level, the east cross-cut was continued east from the main north drift, for an additional distance of 70 feet, passing through very hard porphyry for its entire length. No favorable indications of ore were disclosed by any of the explorations at this depth. On the tenth station (1,500-foot) level, the main east drift from the shaft was continued 294 feet; 495 feet east of the shaft it passed through a clay wall, on the east side of which a well-defined body of quartz was found 4½ feet in width, assaying from $3 to $13 per ton, which may, at greater depths, develop into a productive vein. This drift has been advanced across this vein 180 feet further to the east, through a continuous body of quartz, intermixed with porphyry and gypsum, and is yet being carried forward. The north drift on this level was advanced 359 feet in a northerly direction, passing for its entire length through vein-matter, assaying from $1 to $3 per ton. The main south drift on this level was extended 144 feet southward in the old or west vein. No favorable change having been encountered, the work was discontinued. On the eleventh station (1,600-foot) level the east drift was extended 149 feet further to the east. At a distance of 209 feet from the incline it cut the west clay wall, and passed through the west vein, which is at this point 25 feet in width. A drift was run in this vein from the incline to the southern boundary, and connected with the workings of the Savage mine, thereby insuring the thorough ventilation of the level. From this south drift, at a point 110 feet north of the southern boundary-line, a drift has been run 370 feet to the eastward. This drift has passed for its whole length through quartz, clay, and porphyry, constituting vein-matter of a very low grade, the assays therefrom ranging from $1 to $9 per ton. The east wall has not yet been reached in any of the drifts run eastward on this or the 1,500-foot level. The numerous and extended prospecting drifts run through the old or west vein, from the 425-foot level down to the depth of our present workings, have proven conclusively that this vein, so prolific near the surface, has become of increased barrenness in its descent, and the appearances are very strong that the vein itself will soon entirely disappear.

As the results of the explorations in this western vein continued unfavorable for such a continuous depth, the idea was conceived that the metal-bearing stratum should be found further to the eastward; and the value of the lode within the boundaries of the mine now depends upon the development of this eastern vein, which has not as yet been passed through on any of the deepest levels, since its formation has been discovered. In conducting the search for the metalliferous portions of this eastern ore-vein the cross-cuts to the east on the 1,500-foot level were run in the center and northern portions of the mine. On the 1,600-foot level the cross-drift similarly directed is advancing from the southern portion. It is proposed to continue the exploration of this undeveloped vein by penetrating it in the northern and southern sections of the mine alternately, as each respective level of 100 feet is opened. On the twelfth station (1,700-foot) level a drift has been started east from the incline. It is now 55 feet in length, but has not yet reached the west wall of the west vein. The main incline is sunk and timbered to a depth of 65 feet below the 1,700-foot level. The incline, shaft, and the several car-stations are now in perfect repair. All the pumps from the bottom of the incline to the water-discharge at the adit-level are new, and of an improved pattern. Two sets of new boilers of the most approved pattern have been substituted for the old ones, which were found to be unsafe, and a large and convenient building has been erected for their protection, in place of the old and decayed structure removed. The supply of timbers at the mine is sufficient for its requirements for the winter months. A large reserve of wood is accumulated at the works, and the present daily receipts are equal to the consumption.

From the secretary's report I insert the following:

RECEIPTS.

Cash on hand December 1, 1872	$35,848 83
Bullion account	34,217 57
Mill account	4,604 00
Assessments	207,320 71
Mine account	12,674 00
From rents collected	550 00
Cash indebtedness	61,838 15
Total	357,053 26

DISBURSEMENTS.

Mine account	$297,182 79
Interest	1,016 02
Taxes	2,697 33
General expenses	19,689 28
Exchange	1,400 00
Reducing ores	32,512 42
Freight on bullion	158 35
Legal expenses	2,300 00
Assay account	97 07
Total	357,053 26

Total assets	$182,928 05
Total liabilities	62,443 65

Report of the Savage for the year ending June 30, 1873.

The superintendent, Mr. A. C. Hamilton, reports:

During the twelve months ending June 30, 1873, the Savage mine has yielded $33,414\frac{580}{2000}$ tons ore, which has been extracted from the several sections of the mine as follows:

NEW MINE.

	Tons.	Lbs.
Second level north	14,923	1,180
Third level north	1,785	100
Eleventh level south	4,381	1,800
Twelfth level south	4,508	600
Thirteenth level south	71	
	25,669	1,680

OLD MINE.

	Tons.	Lbs.
Third level	230	1,600
Fifth level	262	700
Sixth level	7,251	600
	7,744	900

All of this ore, together with 295 tons which remained on hand July 1, 1872, has been reduced at custom mills, with the exception of 13¼ tons which were sold. The proceeds of this ore failed to meet the cost of production and reduction, and the result of the year's operations shows a material loss to the company. The avenues from the shaft through the above-mentioned levels being well opened, and the facilities for mining there being complete, the work of extracting ore was continued under the constant hope, and with reasonable grounds of expectation, of reaching, on one or all of these levels, ore of a higher grade, which would prove a source of profit. In the month of April, however, the prospects of accomplishing this desired object seemed so unpromising that it was deemed advisable to discontinue, for the present, all efforts in that direction. No one of these levels can be said to be exhausted of ore, for there still remains in each of them a considerable quantity of low-grade ore which may be made available when labor and materials can be obtained at reduced prices. The mine has been entirely unproductive for the last two months, May and June. In arriving at the results of the year's operations, the expense of the mine for the entire year has been assessed upon the ore produced during ten months, and the average cost per ton, therefore, appears larger than it would be if the calculations were based upon the expense of the ten months only during which ore was extracted.

Since the 1st of July, 1872, the date of my last annual report, the main shaft has been sunk on an incline of 38 degrees—326 feet below the twelfth station—a sufficient depth to allow the opening of two new stations at intervals of 100 feet perpendicular, designated as the thirteenth and fourteenth stations. This last station is about 1,700 feet vertical below the surface. From the thirteenth station a drift was run, southeasterly, to the south line, connecting with the Hale and Norcross mine. Judging from the dip of the vein on the level above, it was naturally supposed that the vein on this level would lie on the east side of this main drift. Two cross-cuts were accordingly run in that direction, but they failed to develop any ore. Three cross-cuts were then run westward, which passed through vein matter of considerable width, consisting of quartz, clay, and porphyry intermixed, and the position of it indicated a straightening up of the vein. In the explorations here made some bunches and seams of ore were found, which for a time gave hopes of favorable results, but as yet no body of ore has been reached. The work of prospecting on this level is still going on. From the fourteenth station a drift has been run, southeastwardly, along the east wall, to within a short distance of the south line, and connection has been made with a winze sunk from the level above near the south line. This connection gives a fine circulation of good air, and every obstacle is now removed from the prosecution of the work of cross-cutting to the west to good advantage and with rapidity.

Below the tenth station the mine has been opened in that portion only which lies on the south side of the main shaft. On the north, between the shaft and the Gould and Curry mine, the ground, from the tenth station down to the thirteenth, has never been penetrated, and remains entirely unprospected. From the thirteenth station a drift has been run northwesterly 572 feet to the north line, and connection has recently been made there with the Gould and Curry mine. This connection is valuable, not only for the purpose of ventilation, but as an outlet which will afford security to life in case of fire or accident from other causes. It will now be comparatively easy to prospect this portion of the mine by cross-cuts driven east and west from this drift.

For some months our progress in the lower levels has been much retarded for want of air, and by the heat which prevailed. The air which was forced down the shaft by means of a blower had to be distributed to so many points that it was not sufficient to enable the men to do efficient work. The connections which I have spoken of, with the aid of a new powerful blower at the surface, have put every part of the mine in a good state of ventilation.

I have discontinued all work at the old mine. All the machinery, tools, and materials used there, which could be made serviceable, have been transferred to the E-street hoisting-works. The old shaft itself remains intact, and will be kept open to serve a useful purpose as a ventilating chimney for the whole mine.

After considerable time spent in repairs and in setting every department in order, I am able to report the shaft and shaft-incline in excellent condition. Six strong and capacious boilers are in place. The engines, machinery, and gear for hoisting and for pumping, are in perfect order, and possess ample power and strength to work the mine considerably deeper. In short, everything is in readiness to resume the sinking of the shaft incline, and to carry on the work of opening and developing the lower levels with unprecedented vigor.

The condition of the company's mills at Washoe remains unchanged. The property is placed in the care of a watchman to look out for its preservation, and to comply with the conditions of the policy of insurance.

Condensed statement of the operations of the Savage Mining Company for the year ending June 30, 1873.

	Tons.	Lbs.	Tons.	Lbs.
Ore on hand July 1, 1872, at mine			295	
Ore produced			33,414	580
			33,709	580
Ore reduced	33,695	1,580		
Ore sold	13	1,000		
			33,709	580

PRODUCT.

Bullion:		
From 33,695$\frac{1580}{2000}$ tons ore reduced		$449,771 78
From slag, &c., in assay-office		2,392 72
		452,164 50
Cash:		
For ore sold, 13½ tons		21 65
		452,186 15
Less net amount of mill reclamations		4,234 27
Product of ore		447,951 88
Cash:		
For materials sold	$1,597 85	
For sundries	175 57	
		1,773 42
Total product		449,725 30

EXPENSE.

Cost of production of ore, (33,414$\frac{580}{2000}$ tons:)

Mine cost:	
Labor	$302,895 50
Materials	153,535 90
	456,431 40

Assaying bullion	$3,334 07	
Assaying ore	3,472 21	
Other incidental expenses	23,866 87	
	487,104 55	
Cost of reduction of ore, ($33,695\frac{1580}{2000}$ tons)	404,349 48	
		$891,454 03
Total loss		441,728 73

	Per ton.
Average yield of the ore reduced, including bullion from slag and mill reclamations	$13 29

Cost of production:

Mine cost, (labor, $9.07; materials, $4.59)	$13 66
Assaying bullion	10
Assaying ore	$10\frac{4}{10}$
Other incidental expenses	$71\frac{6}{10}$
	14 58
Cost of reduction	12 00
	26 58
Average loss from the ore reduced per ton	13 29
Average assay value of the ore reduced per wagon samples per ton	$21 86
Average yield of the ore reduced, in bullion, per cent. of assay value	61.4
Average yield of the ore reduced, in bullion, including all reclamations, per cent. of assay value	60.8

	Gold.	Silver
Proportions of gold and silver in the ore	26.2	73.8
Proportions of gold and silver in the bullion	29.5	70.5
Percentage returned of the gold and silver contained in the ore	68.8	58.3

Average value of the bullion per ounce after melting, $1.77½.
Average loss in weight in melting, $2\frac{7}{10}$ per cent.

Comparative statement.

For year ending June 30.	Ore produced (not including ore extracted from old mine on con't s'ld.)		Ore reduced.		Cost of production.	Cost of reduction.	Total cost.	Yield of ore reduced.	Profit.	Loss.	Proportions of gold and silver in the ore, third class.			
											Per wagon samples.		Per mill samples.	
	Tons.	Pounds.	Tons.	Pounds.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Gold.	Silver.	Gold.	Silver.
1867.	70,721	620	69,376	1340	$7 91	$14 04	$21 95	$41 94	$19 99	......	......	......	26.9	73.1
1868.	83,444	1250	84,696	1670	7 21	13 74	20 95	40 84	19 89	......	27.9	72.1	28.8	71.2
1869.	53,953	1350	55,479	760	8 90	12 22	21 12	34 87	13 75	......	25.1	74.9	26.4	73.6
1870.	14,051	500	13,272	600	26 87	10 01	36 88	20 67	......	$16 21	27.0	73.0	27.1	72.9
1871	30,715	1150	38,147	290	11 06	9 95	21 01	21 43	42	......	27.8	72.2	......	......
1872.	47,505	1660	48,392	1790	10 15	11 80	21 95	18 70	......	3 25	28.3	71.7	......	......
1873.	33,414	580	33,605	1580	14 58	12 00	26 58	13 29	......	13 29	26.2	73.8	......	......

Tabular statement of the results of reduction of ore, by the Savage Company, in connection with the assay value of the ore as determined by samples taken from the wagons, from July 1, 1872, to July 1, 1873.

Months.	Quantity of ore reduced.		Total assay value of the ore.	Total bullion produced.	Assay value of the ore per ton.			Bullion produced per ton.			Yield per cent. of the assay value of the ore.		
	Tons.	Pounds.			Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
1872.													
July	5,184	1,600	$103,166 31	$64,465 80	$5 24	$14 65	$19 89	$3 75	$8 68	$12 43	71.6	59.2	62.5
August	4,854	1,500	97,115 09	59,829 15	5 20	14 80	20 00	3 65	8 67	12 32	70.1	58.6	61.6
September	5,461	950	125,061 77	75,049 97	6 08	16 82	22 90	4 04	9 70	13 74	66.5	57.6	60
October	3,899	800	97,276 87	58,841 65	6 71	18 23	24 94	4 42	10 67	15 00	65.8	58.5	60.5
November	3,791	....	80,954 21	49,779 75	5 34	16 01	21 35	3 84	9 29	13 13	71.9	58	61.5
December	3,904	650	83,227 40	50,217 84	5 66	15 65	21 31	3 86	9 00	12 86	68.2	57.5	60.4
1873.													
January	3,091	1,200	73,401 21	44,036 47	6 43	17 31	23 74	4 37	9 88	14 25	67.9	57	60
February	1,477	800	33,736 66	17,925 41	6 22	16 61	22 83	3 59	8 54	12 13	57.8	51.4	53.1
March	1,258	1,150	25,861 62	16,110 99	4 80	15 75	20 55	3 56	9 24	12 80	74	58.7	62.3
April	772	930	16,944 20	13,169 56	4 79	17 14	21 93	4 16	12 89	17 05	86.7	75.2	77.7
May	....	....	....	345 19	....	....	....	....	....	....	....	....	....
June	....	....	....	....	....	....	....	....	....	....	....	....	....
Totals	33,695	1,580	736,745 34	449,771 78	....	....	....	....	....	....	....	....	....
Averages	....	....	....	....	5 72	16 14	21 86	3 94	9 41	13 35	68.8	58.3	61

The secretary's report gives the following receipts and disbursements:

RECEIPTS.

Bullion:	
Bars received from mine	$452,164 50
Scraps of bullion sold	19 07
	452,183 57
Less reclamations on bars	109 28
	452,074 29
Assessments Nos. 6, 7, 8, and 9	640,000 00
Virginia and Truckee Railroad Company, one-half freight-charges refunded	10,884 31
Atchison mill, old lumber sold	444 00
Ores, 13½ tons and refuse from dump	57 65
Total	1,103 460 25

DISBURSEMENTS.

Cash balance overdrawn July 10, 1872	$133,708 53
Labor and salaries	308,783 50
Wood and charcoal	66,087 31
Timber and lumber	55,635 12
Paid custom mills	408,663 75
Mining supplies and insurance on hoisting-works	46,040 22
Virginia and Gold Hill Water-Works	9,600 00
Assay-office	7,258 23
State, county, and city taxes	7,443 46
Freight on materials to Virginia	1,243 07
Surveying in mine	900 00
Exchange, discount, and interest on money borrowed and overdrafts at bank	28,479 62
General and legal expenses	18,463 85
Real estate at Virginia	450 00
Cash balance on hand this day	10,703 59
	1,103,460 25

Report of the Hale & Norcross mine for the year ending February 28, 1873

The president, Mr. J. C. Flood, reports as follows:

The past year has not been a profitable one for the stockholders of the Hale & Norcross Mining Company. The hopes expressed at the last annual meeting of this company, as regards finding pay-ore on the 1,700-foot level, have not been realized; and an additional level 200 feet below, making 1,900 feet from the surface, has since been opened, without realizing any benefit therefrom. Indications, however, on this last level, lead to the belief that a body of ore will be developed on the next level below—the sinking for which has been already commenced, and the depth of 2,000 feet will be reached in sixty days, when further prospecting will be carried on at that depth.

The very heavy expense of carrying on mining at the depth of 1,900 feet is apparent to every one at all familiar with the subject, and it is with confidence I refer stockholders and others to the economical administration of affairs of this company for the year just ended.

The superintendent, Mr. James G. Fair, reports:

During the past year 28,645$\frac{1800}{2000}$ tons of ore have been extracted from the several levels of the mine, and 28,966$\frac{1815}{2000}$ tons have been reduced, the principal portion of which was the product of the old upper levels; and there is now on hand in the ore-houses 1,689$\frac{144}{2000}$ tons, valued by assay at $57,823.84. Within this period the main incline has been sunk from the 1,700 to the 1,900 foot level. At the last-mentioned depth the horizontal drift from the incline has been continued in the vein to the northern boundary of the mine. Three cross-drifts have been driven through the vein, from the east to the west wall, at regular intervals. Another drift has been advanced on this level to a distance of 140 feet south from the incline, at which point a cross-cut has also been run from the east to the west wall. In the various openings thus far made at this depth, two narrow seams of ore of good quality have been encountered, which, although continuous so far as explored, have not yet developed to a sufficient width to permit of the profitable extraction of the ore therefrom. The vein on this level is of much greater width than on the 1,700-foot level above; the formation is much softer, and the general appearance of the vein-matter is greatly improved. The ore thus far disclosed is of good quality, and is of unbroken continuity. The vein has now well-defined east and west walls, and its characteristics are identical with those of the ore-producing levels above. The main incline is already sunk 40 feet below the lowest level, and within fifty days from the present date the 2,000-foot level can be reached. Judging from the indications shown by our latest explorations, this level will be ore-producing. Meanwhile the 1,900-foot level, which is as yet not partially opened, will be thoroughly explored. The shaft, incline, and all of the hoisting and pumping machinery are in good condition.

The secretary's report gives the following receipts and disbursements to February 28, 1874.

RECEIPTS.

Amount brought forward from February, 1873		$41,300 07
Received from sales of materials, &c		8,820 16
Received from assessments		233,577 00
To cash, proceeds 28,966$\frac{1225}{2000}$ tons ore, viz:		
Bullion	541,771 69	
Samples, charged assay-office	267 12	
Slag-bullion	2,826 74	
Received from ores worked		544,865 55
To cash, bullion received on account February (1874) workings		11,088 63
Total		839,651 41

DISBURSEMENTS.

February 28, 1874.

By amount bullion received on account, February (1873) workings, charged cash in last annual statement, and credited as portion of this year's receipts		$53,114 24
Mine account:		
Labor	$213,264 61	
Hardware, iron, &c	5,661 02	
Timber, lumber, and freight	28,417 13	
Lagging and freight	1,455 00	
Wood and freight	48,713 25	
Freight on supplies	1,829 54	
Hauling	448 30	
Water	5,750 00	
Powder, fuse, &c	6,302 28	
Rope	84 72	
Rubber goods	744 71	
Brick, lime, cement, &c	133 69	
Candles, oils, &c	6,160 20	
Paints, oils, varnish, &c	973 12	
Tallow	331 20	

Coal and coke	$3,083 52	
Charcoal	2,864 17	
Ice	697 82	
Fire annihilator	110 00	
Pipe	275 62	
Sundry small supplies	375 12	
Total to mine account		$327,675 02
Tax account:		
Nevada State and county tax	2,224 46	
Mine tax on proceeds	2,058 72	
Virginia City tax	609 46	
Total taxes paid		4,892 64
Machinery account:		
Repairs, pump, &c		1,625 65
Team account:		
Team account		2,266 19
Assay-office account:		
Salaries, assayer and assistants	5,716 66	
Supplies, &c	1,930 08	
Muffler furnace, bricks, cement, &c	250 61	
Bullion samples	267 12	
Total to assay-office account		8,164 47
General expense account:		
Counsel fees	2,000 00	
Discount on drafts	1,668 97	
Contributions and medical expenses	250 00	
Freight on bullion	2,272 40	
Commission on purchases	51 75	
Interest	2,329 31	
Insurance	2,030 00	
Sundry expenses, Virginia and San Francisco	3,068 86	
Discount on bullion	9,554 96	
Salaries president, secretary, superintendent, foreman, and clerk	18,000 00	
Stationery, Virginia and San Francisco	483 49	
Surveying	350 00	
Total general expenses		42,059 74
Ore account:		
Paid working $28,966\frac{1226}{2000}$ tons		347,599 35
James G. Fair, superintendent:		
Amount his book-account		5,296 82
Total disbursements		792,694 12
Cash, per cash-book to balance		46,957 29
Total		839,651 41

Hale & Norcross ore-table, February 1, 1874.

	Proportion of metals in the ore.	Assay values.				Yield.			Loss.		
		Quantities.		Per ton.	Amount.	Per ton.	Per cent. of assay value.	Amount of bullion.	Per ton.	Per cent.	Amount.
		Tons.	Lbs.								
Three months ending April 30, 1873		12,430	790								
Gold	.33			$9 21	$114,472 40	$6 96	.76	$86,550 32	$2 25	.24	$27,922 17
Silver	.67			19 05	236,894 63	11 70	.61	145,544 48	7 35	.39	91,350 15
Ore				28 26	351,367 12	18 66	.66	232,094 80	9 60	.34	119,272 32
Three months ending July 31, 1873		6,090	1,320								
Gold	.35			11 53	70,237 53	7 72	.67	47,023 84	3 81	.33	23,213 69
Silver	.65			21 34	129,963 50	15 08	.71	91,844 53	6 26	.29	38,118 97
Ore				32 87	200,201 03	22 80	.69	138,868 37	10 07	.31	61,332 66
Three months ending October 31, 1873		7,089	920								
Gold	.33			7 47	52,968 22	4 88	.65	34,605 06	2 59	.35	18,363 16
Silver	.67			14 95	106,009 43	11 18	.75	79,277 60	3 77	.25	26,731 83
Ore				22 42	158,977 65	16 06	.72	113,882 66	6 36	.28	45,094 99
Three months ending January 31, 1874		3,356	905								
Gold	.30			7 55	25,338 73	5 68	.75	19,075 65	1 87	.25	6,263 08
Silver	.70			17 40	58,415 41	12 20	.70	40,944 67	5 20	.30	17,470 74
Ore				24 95	83,754 14	17 88	.72	60,019 72	7 07	.28	23,734 42
Twelve months ending January 31, 1874		28,966	1,225								
Gold	.33			9 08	263,016 97	6 46	.71	187,254 27	2 62	.29	75,762 70
Silver	.67			18 34	531,282 97	12 35	.67	357,611 28	5 99	.33	173,671 69
Ore				27 42	794,299 94	18 81	.68½	544,865 55	8 61	.31½	249,434 39
Eight years ending January 31, 1874		290,929	725								
Gold	.32			12 11	3,633,457 15	9 24	.76	2,772,468 28	2 87	.24	860,988 87
Silver	.68			26 16	7,845,914 63	15 92	.61	4,774,187 26	10 24	.39	3,071,727 37
Ore				38 27	11,479,371 78	25 16	.65½	7,546,655 54	13 11	.34½	3,932,716 24

Report of the Chollar Potosi for the year ending May 31, 1873.

The president, Mr. A. K. P. Harmon, says:

I regret that it is not in my power to congratulate you upon any new discoveries in the working of the mine during the past twelve months—notwithstanding a most thorough exploration—but, as will be seen by your superintendent's report, there are not wanting indications, at this writing, of new deposits being reached, which, let us hope, may be valuable enough to reward the protracted efforts made in their search.

The quantity of ore extracted from the mine during the past financial year exceeds that of the preceding term by over 10,000 tons, but owing to a greater admixture of base metal, the final results were not so favorable.

* * * * * * *

The superintendent, Mr. Isaac L. Requa, reports:

Operations at company's mine have been steadily prosecuted, with the following results:

	Tons.
Ore extracted	48,200
Ore reduced at mills	44,050

The ore mined came from—

	Tons.
Blue Wing, west	14,000
Piute	13,000
Grass Roots	11,150
Second Station, New Shaft	10,050

As indicated by the above-named sections, ore supplies for past twelve months have been drawn from the old and long-developed portions of the mine. Notwithstanding much prospecting work has been done, in quarters of the mine that indicated the existence of precious metal, our labors and expenditures of money are, I regret to say, unrewarded, and the hope for deposits of ore are undiscovered. At fourth station of shaft, in drift north, there are strong probabilities of our getting ore of average quality; every effort has been made to reach this body of ore said to exist near this company's north line. Owing to the swelling of the ground through which the drift passes, and the steady and constant crushing of timbers, the work of completing this drift has been delayed far beyond the estimated time, and deprives us of the anticipated pleasure of positively announcing to you the existence of ore on this company's ground at the point designated.

Since the last annual communication, the main shaft has been fully and completely repaired, pumping machinery re-organized, new and very efficient pumps placed in the shaft. Also strong and powerful machinery has been erected for use in the incline. New steel-wire ropes for incline and shaft are in use. In brief, the entire detail of operating at "New Shaft" is in complete condition. In connection with the ordinary machinery, we have added a machine for compressing air—said air to be used as a motive-power at low levels. Owing to delays in perfecting the compressor, no use has been made of it. In the carpenter-shop, large circular saws and the necessary machinery for driving them have been attached to the facilities of this department. Necessarily, in the accomplishment of these numerous improvements, including the re-opening of the new shaft, outlays of money were requisite—hence the large expenditure over the receipts for the current year. Concerning the reserves of ore, no correct estimate can be made. The quantity developed at this time is more extensive than the known supplies were one year ago. During the past twelve months much of the ore milled was largely impregnated with base metals, causing much difficulty in reducing and materially curtailing the results in bullion. Space for depositing waste from the mine became totally absorbed. In order to obtain abundance of room for dumping *debris* the erection of a heavy trussed railway over the Virginia and Truckee Railroad was found indispensable. This work is complete and will afford ample extent for all time to come.

Condensed statement of cost, production, &c., of Chollar Potosi Mining Company, from June 1, 1872, *to May* 31, 1873.

Ore statement:

	Tons.	Lbs.
Ore on hand June 1, 1872	2,766	130
Ore extracted during year	45,338	1,070
	48,104	1,200
Ore worked* during year	44,255	680
Ore on hand June 1, 1873	3,849	520

* Worked, 44,050 tons. Sold, 205 tons 680 pounds.

Cost per ton:

Extracting ore	$2 93
Repairs, prospecting, dead work and incidentals	1 60
New shaft	3 11
	7 64
Reduction, including melting and assaying	11 09
Total cost per ton	18 73
Average yield of ore worked	15 57
Average net loss of ore worked	3 16

Bullion:

Average value of bullion per ounce, gold 75 cents; silver $1.23; total $1.98. Average fineness of bullion per ounce, gold .036; silver .958; total .994. Average proportion of precious metals, gold .38; silver .62; total 100.

Work of assay-office:

Ounces of bullion assayed before melting	354,926.60
Ounces of bullion assayed after melting	345,636.35
Average loss in melting, per centum	2.6
Number of ore assays made	7,988
Number of bars made	249

Receipts and expenses.

Received from bullion	$685,809 17	
Received from other sources	2,340 34	
		$688,149 51
Expenses by all sources		824,990 01
Net expense for year		136,840 59

The secretary's report gives the following:

RECEIPTS.

Bullion account:		
Proceeds of bullion sold		$685,723 55
Assessment account:		
Assessment No. 4 levied February 13, 1872	$140,000 00	
Advertising charges received	334 50	
		140,334 50
Sales of ores:		
Received from sale of 205 tons ore, @ $5 per ton		1,025 00
Superintendent Requa:		
This amount received from him, being last year's balance		4,128 74
Cash account:		
Cash on hand as per last statement		174,148 82
Total		1,005,360 61

DISBURSEMENTS.

Working ores	$483,255 00
Labor	198,853 48
Timber and lumber	57,304 88
Hardware	16,636 57
Coal	2,770 86
Candle	3,643 30
Powder	1,248 25

Oil	$329 50
Wood	10,008 77
Water	6,600 00
Assaying total expense, less $168.69 received for assays	1,001 99
Taxes on real estate in Virginia and ore extracted	4,426 52
Stable	2,077 03
Rent	730 00
Stationery	628 62
Legal expenses	6,106 00
Surveying	900 00
Real estate purchased	120 00
Discount and interest	9,888 88
Freight	11,271 94
Machinery and materials	43,725 99
Incidental expenses, insurance, &c	8,940 57
Due on superintendent's account	1,499 53
Cash on hand	133,392 03
Total	1,005,360 61

Report of the Crown Point for the year ending May 1, 1873.

The report of the superintendent, Mr. J. P. Jones, presents the history of the operations at the company's mine for the last three years in a very plain and intelligible manner. He says:

> The last general report submitted by the superintendent was dated May 1, 1870. At that time the Crown Point mine was yielding nothing. There was no ore in sight of sufficiently high grade to pay the cost of extraction and reduction. Nor was there anywhere in the mine any indication of a coming ore-body. The company's mill was leased at the very moderate monthly rental of $1,000. The future prospects of the company never looked so unpromising. Work in the mine was principally confined to the 1,100-foot level, where a prospecting drift had been driven due east from the shaft a distance of 800 feet, at which point, nothing but porphyry and barren seams of quartz having been exposed throughout its entire length, it was discontinued. It being apparent that further exploration in that direction would prove futile, a drift was started almost due south of the above-mentioned drift at a point 360 feet east of the shaft and 101 feet south of the north boundary line. In this drift, at a point 340 feet south of the north boundary line, a clay wall, running northeast and southwest, was diagonally traversed. The drift was then turned directly east, and continued for 20 feet through soft whitish quartz, containing occasional spots of ore. It next cut a formation of porphyry about 10 feet in thickness, somewhat decomposed and resembling soapstone in appearance, which proved to be the west or foot wall of an ore-body about 1 foot wide and bounded on the east by a hard casing. The ore consisted of bowlders incased in cement, which would yield in the mill about $40 per ton. The drift was then further continued in a southeasterly direction 38 feet, skirting the foot-wall, when the ore-body suddenly widened to 13 feet, and continued at that width for 20 feet further south, at which point the east wall made rapidly toward the east until the ore-body had attained a width of 84 feet. The drift was extended until the southern boundary line of the claim was reached, developing a continuous and uniform body of ore its entire length. This ore-body was also explored by a raise along the west wall, which dips easterly at an angle of about 38 degrees, until it reached the 1,000-foot level, where it was intersected by a drift from the main shaft, after which it was followed by a series of winzes and raises to the 900-foot level. How much higher it may extend will be determined by future explorations. But little is as yet known of the extent of the ore-body on the 900-foot level, the prospecting being confined to a drift 80 feet in length, commencing at the southern boundary line and running northerly. Throughout the entire length of this drift a body of ore, 9 feet in width, was found, which averaged $38 per ton.
>
> The ore-body on the 1,000-foot level is 200 feet in length, and has an average width of about 45 feet. But little ore has been extracted from this level, the entire workings being confined to an area 190 feet long, with an average height of 23 feet. The ore on this and the 900-foot level is held as a reserve in case of an accident to the main in-

cline or machinery, which might impede or temporarily prevent work on the lower levels. The 1,000-foot level is in good condition to work at any time; the drifts and chutes are in good repair, and ventilation is secured by winzes connected with the 900-foot level.

The ore-body on the 1,100-foot level is 255 feet in length by 58 feet in width, and has been worked out for a distance of 240 feet north of the south line. On this level there are from 30,000 to 40,000 tons of low-grade ore stored away in cribs, carefully marked and available for extraction at any time, which will yield a small margin of profit over the cost of hoisting and reducing.

While the upper levels were being prospected, the main incline was driven steadily down preparatory to opening and exploring the 1,200-foot level. As soon as this level was reached, a station was cut out and a drift started south, following the course of the west wall, and continued until the southern boundary line was reached. From this drift two cross-cuts were made—one 120 feet and the other 220 feet from the south line. The former showed the vein to be 118 feet in width and the latter 76 feet. The very rich ore on this level was confined to the 15 feet next the west wall; the remainder of the ore was of very good quality and character and remarkably free from waste. The ore-body on this level is 310 feet in length, and averages about 70 feet in width, about three-fifths of which have been extracted and reduced. This is exclusive of the eastern ore-body, hereinafter described, which has not been worked at all.

In breasting out on the sill-floor of the 1,200-foot level, at a point 102 feet east of the west wall and 100 feet north of the south line, a hard, flinty wall of quartz was struck, which was considered the eastern boundary of the pay ore and practically the east or hanging wall. In order to ascertain how far east this barren quartz would extend, a cross-cut was started at the point referred to and driven 36 feet east, where ore of very fine quality was found, 6 feet wide, and bounded on the east by a porphyry wall, which is now believed to be the east wall. The course of this new ore-body is south, 36° east, and it has been followed by a drift to the south boundary line, showing ore of the same good quality all the way. This drift was also extended northerly until it intersected the south cross-cut, exposing the same character of ore throughout its entire length. A winze was then commenced at the point where the cross-cut first struck the ore, and continued down along the east wall, which here dips easterly at an angle of about 32°, and has now reached a depth of 120 feet on the line of the dip, or 70 feet vertically, showing excellent ore the entire distance. This ore-body has been further explored from the third and fifth floors of the 1,300-foot level, and in order that my description of the same may be continuous, I will complete it before describing the opening and working of that level.

On the fifth floor, 1,300-foot level, in breasting out at a point 100 feet north of the south line and 90 feet east of the west wall, the same barren wall of quartz was encountered, which has been heretofore referred to as the apparent eastern boundary of the pay ore on the 1,200-foot level. From this point a cross-cut was made to intersect the above-mentioned winze. Sixty feet east of the starting-point ore of fair quality was found which will, with a little assorting, yield $25 or $40 per ton. This lasted for 20 feet, when a formation of porphyry, 16 feet in width, was cut, followed by another body of ore of excellent quality, averaging $80 per ton, which continued for 27 feet, where the intersection with the winze was completed. The entire length of this cross-cut, it will be seen, is 123 feet, of which 47 feet is solid ore, and the entire distance between walls 213 feet, of which 137 feet is ore.

A similar cross-cut was started on the third floor of the 1,300-foot level, at a point 35 feet north of the south line and 72 feet east of the west wall. Ninety-one feet east of the place of beginning a body of ore was struck four feet wide, which averages $70 per ton. Next to this was found a formation of porphyry, which continued for 7 feet, at the end of which another body of ore was cut, 10 feet wide, which averages $90 per ton, and is bounded on the east by the hanging wall. Still another cross-cut has been started to intersect the winze at a point on the sill-floor of the 1,300-foot level directly under the cross-cut on the fifth floor. This last cross-cut is now in 47 feet, and has cut thus far only barren quartz and porphyry, not having yet reached the point where the eastern ore-body should be found. As this ore-body was only 6 feet wide where first struck on the sill-floor of the 1,200-foot level, and had already increased to 47 feet in width at the fifth floor of the 1,300-foot level, a still further increase in width may be reasonably expected on the sill-floor of that level.

The ore-body in the 1,300-foot level is 360 feet in length, and has an average width of 90 feet. This is by far the richest and most extensive level ever opened on the Comstock lode. It will be remembered that on the 1,200-foot level the very rich ore was confined to a belt, 15 feet in width, lying next to the west wall. On the 1,300-foot level the rich ore is confined to no particular part, but the whole level shows a high and uniform grade of ore from wall to wall. On this level nine floors have been opened for a distance of 165 feet north of the south line, and on every floor ore of excellent quality has been found. The remaining 195 feet has not been worked at all, and even on the nine floors referred to an immense amount of first-class ore yet remains. The ore in the northern half of the level, however, appears to be of lower grade than that in the southern half, and is not expected to yield more than two-thirds as much. The 1,300-foot level has already yielded about $4,000,000 in bullion, and will probably yield about $10,000,000 more, about 75 per cent. of which will be net profit. The following table shows the average yield per ton for the six months just past—during the last three months of which a large proportion of the ore extracted came from this level—and indicates more clearly than any description the extraordinary increase in the value of the ore:

Average per ton for November, 1872	$30 58
December, 1872	32 96
January, 1873	41 18
February, 1873	61 98
March, 1873	70 72
April, 1873	82 11

On the 1,400-foot level a large and commodious station has been cut out, and a double drift run from it 142 feet south, from which point the level will be opened at the earliest practicable moment.

The main incline has also been driven down to the 1,500-foot level, and preparations made to cut out the station there.

A recapitulation of the foregoing details will enable one to acquire a very good general idea of the form and character of the great Crown Point bonanza. It may be briefly described as an immense wedge-shaped body of ore, with its edge uppermost, having a strike or course northwest and southeast, and penetrating the earth with an easterly dip of about 36°.

On the 900-foot level the upper edge or apex has been developed for 80 feet in length, with an average width of nine feet, and an average value of about $28 per ton.

On the 1,000-foot level the ore-body is 200 feet in length, with an average width of 45 feet, and an average value of $32 per ton.

On the 1,100-foot level it is 255 feet in length, with an average width of 58 feet, and an average value of about $37 per ton.

On the 1,200-foot level it is 310 feet in length, with an average width of 70 feet, and an average value of about $45 per ton.

On the 1,300-foot level it is 360 feet in length, with an average width of 90 feet, and an average value of about $75 per ton.

It thus appears that the ore-body has steadily increased in length, width, and richness as we have descended upon it, and there is every indication of its continuing to do so. Much significance has been attached, and I think justly, to the fact that ever since this chimney of ore was struck, the various seams and stratifications of whatever kind, whether clay, porphyry, barren quartz, or ore, have uniformly maintained about the same course and dip as the walls encasing them. When it is remembered that in the ore-bodies worked prior to this discovery there was no such uniformity, but the chimneys were as likely to stand vertical as any other way, it is fair to presume that we have passed below the range of surface-disturbance, and that the vein will penetrate the earth in its present shape to an indefinite depth.

From this immense chimney we have extracted and worked about one-seventh of the ore between the 900 and 1,000 foot levels, about four-fifths of the ore between the 1,000 and 1,100 foot levels, about three-fifths of the ore between the 1,100 and 1,200 foot levels, and about one-fourth of the ore between the 1,200 and 1,300 foot levels. Above the 900-foot level the ore remains untouched. In the aggregate we have taken out and crushed from May 1, 1871, to May 1, 1873, 217,431 $\frac{10}{2000}$ tons, which have given a gross yield of $9,944,783.57, and an average yield of $45.73 per ton. We have in reserve and available for immediate extraction the remainder of the ore, as indicated by the foregoing figures, in the levels above the 1,300, and have now everything in readiness to open the 1,400 and 1,500 foot levels.

In addition we have made a new and very promising development, as heretofore described, in the 1,200 and 1,300 foot levels, eastward of the main chimney, which seems to be the upper portion of another wedge-shaped ore-body, similar to and overlapping that first discovered. This may continue in depth, as an independent chimney, or unite with the other to form one large ore-body. I regard the latter as the more probable, but in either event the importance of this development can hardly be overestimated.

In December, 1870, when the ore-body was first discovered, the Crown Point was simply a prospecting mine, and had none of the necessities or conveniences required for the extraction and hoisting of the immense quantities of ore which it soon became necessary to move. The shaft was small, inconvenient, and out of repair; the hoisting-machinery was competent only for the work of prospecting; the pumping-apparatus was insufficient; and the ventilation entirely inadequate for an active-producing mine. Since then the shaft has been enlarged by sinking another compartment 1,100 feet deep, and its working capacity increased by putting double cages in all three compartments. It has also been repaired from top to bottom, and the timbering, which was beginning to press inward on account of the swelling of the ground around it, has been relieved by cutting out the ground for two feet in width all the way around to the bottom of the shaft, and made secure by retimbering in the most substantial manner. Three new engines, of 80-horse power each, supplied by four new boilers, each 54 inches in diameter, have been put in place in the hoisting-works. Four reels, five sheave-wheels, one new spur-wheel for pump, one new pump-bob and connecting-wheel for same, one new 9-inch shaft for spur-wheel, one new pinion-wheel, and two new donkey-pumps have been also added. A coal-dump has been constructed of 350 tons capacity, so situated as to enable one man to deliver at the furnaces all the coal used about the mine; and a water-tank built, in conjunction with the Virginia and Truckee Railroad Company and the Yellow-Jacket Mining Company. This tank has a capacity of 190,000 gallons, is situated 300 feet above the hoisting-works, and connected with them by iron pipes. Six hundred feet of the best carbolized hose are kept ready in case of fire, and thirty of Babcock's fire-extinguishers have been purchased for use around the works or in the mine if required. Two blacksmith-shops have been built in the mine, one on the 1,200 and the other on the 1,300 foot level, to save the expense of hoisting and lowering tools for repairs.

In the work of prospecting, developing, and ventilating there have been—raises made, 275 feet; winzes sunk, 1,289 feet; cross-cuts run, 1,330 feet; drifts run, 3,826 feet; drifts retimbered, 800 feet.

Since opening the 1,300-foot level it has become necessary to put in alternate sets of timber and bulkheads, filling them up behind as close as possible with waste, thereby rendering them almost as solid as the earth itself. This requires much more timber than the ordinary system, but it has been adopted on the principle that it is cheaper to prevent caves than to repair them. During the year ending May 1, 1872, there were used in and about the mine 2,920,000 feet of lumber and timber. For the year ending May 4, 1873, there were used 4,760,000 feet, being an increase of 1,840,000 feet for the year. This great increase in the consumption of lumber and timber was occasioned partly by the more energetic working of the mine, and in no small degree by the present system of timbering.

Since the last report there have been expended $16,057.37 on the company's mill for repairs and additions.

* * * * * * *

In conclusion I desire to say that in my opinion the prospects of the Crown Point mine are now far brighter than they ever were before. Its history for the past three years has already made it one of the most notable in the annals of mining, and I am confident that this history will repeat itself in future levels, to an indefinite depth.

The secretary's report contains the following items of interest:

RECEIPTS.

Bullion		$6,442,785 02
Mine expense:		
Supplies to Kentuck Company	$451 72	
Lumber sold	804 02	
Difference on rope returned	625 93	
Supplies sold	50 20	
Yellow Jacket Company's one-third tank	1,436 20	
Railroad company's one-sixth tank	718 10	
Railroad company's wrecked cars	104 25	
		4,190 42
Rhode Island Mill:		
Old pan sold	75 00	
Old tubes sold	100 00	
		175 00
Discount on sundry bills		33 75
John P. Jones, balance per report May 1, 1872		14,007 63
Cash in treasury May 1, 1872		644,507 09
Total		7,105,698 91

DISBURSEMENTS.

Mine expenses:		
For labor	$771,317 25	
For lumber	175,522 07	
For wood	66,858 33	
For castings and foundery work	17,652 04	
For freight on supplies	5,982 71	
For candles, oils, hardware, iron, steel, rope, &c	147,294 21	$1,184,626 61
Mine improvements:		
For machinery and castings	12,769 81	
For tank, Yellow Jacket Company	2,185 17	
For bricks	700 00	
For labor	146 00	
For lumber, lime, hauling, &c	479 79	16,280 77
Rhode Island Mill:		
For labor	35,537 25	
For wood	43,744 85	
For castings	18,474 40	
For water	8,400 00	
For quicksilver, hardware, &c	38,232 82	144,389 32
Crushing:		
For working 121,828$\frac{1488}{2000}$ tons		1,463,824 00
General expense:		
For superintendent's salary, Gold Hill office, insurance, &c		32,619 70
Legal expense:		
For attorney's fees and adverse claims		6,957 65
San Francisco expense:		
For salaries, office, and stationery		10,514 52
Interest:		
At Gold Hill		1,855 64
Assaying:		
For ore assays	$6,874 97	
For bullion assays	19,686 23	26,561 20
Taxes:		
For city and county	7,579 86	
On ore	34,849 14	42,429 00
Dividends:		
Nos. 25, 26, 27, 28, 29, 30		2,180,000 00
Discount:		
On drafts	5,982 63	
On bullion	80,762 73	86,745 36

Assay-office:		
For assaying balances and weights		$2,475 00
Treasure freight:		
Transportation of bullion		22,212 58
Real estate:		
Lot for assay-office	$5,000 00	
Lot corner Crown Point and Main streets	5,000 00	
		10,000 00
Sundry book accounts		316 15
Cash in treasury May 1, 1873		1,873,891 41
Total		7,105,698 91

ORE STATEMENT.

Tons.	Lbs.		Yielding—
		Worked at Rhode Island Mill.	
15,064	1,830	(average per ton, $45.20) yielded	$681,092 13
		Worked at Petaluma Mill.	
11,067	1,850	(average per ton, $52.28) yielded	578,685 31
		Worked at Mexican Mill.	
31,923	1,580	(average per ton, $45.54) yielded	1,453,889 15
		Worked at Brunswick Mill.	
35,447	1,180	(average per ton, $45.97) yielded	1,629,726 66
		Worked at Morgan Mill.	
13,790	1,620	(average per ton, $47.61) yielded	656,589 04
		Worked at Pioneer Mill.	
10,153	1,020	(average per ton, $47.74) yielded	484,746 42
		Worked at Atlas Mill.	
5,494	600	(average per ton, $55.12) yielded	308,375 94
		Worked at Sapphire Mill.	
6,874	150	(average per ton, $45.89) yielded	315,949 15
		Worked at Trench Mill.	
1,004	960	(average per ton, $35.92) yielded	36,087 02
		Worked at Spring Valley Mill.	
2,565	650	(average per ton, $31.94) yielded	79,535 93
		Worked at Gold Hill Quartz Mill.	
856	250	(average per ton, $53.75) yielded	46,022 46
		Worked at Woodworth Mill.	
1,279	1,100	(average per ton, $72.83) yielded	91,192 65
		Worked at Douglas Mill.	
1,371	500	(average per ton, $58.40) yielded	80,083 03
136,893	1,290	Totals	6,441,974 89

Average yield per ton for the year.

There were $136,803\frac{1290}{2000}$ tons of ore worked, yielding $6,441,974.89; making the average yield per ton $47.05.

BULLION STATEMENT.

Stamped value of bullion, as per assay certificates received at the office in San Francisco, credited on the books of the company:

Value of gold	$2,826,458 17
Value of silver	3,587,189 41
Assay, grains and chips	27,526 21
Reclamation Spring Valley Company	801 10
Wrecked cars, ore lost, V. & T. R. R.	835 34
	6,442,810 23

Contra.

Reclamation to L. & S. F. Bank on bar 8198	25 21
	6,442,785 02

WEIGHT.

	Ounces.
Amalgam before melting	3,000,636.30
Amalgam after melting	2,953,591.85
	47,044.45—Loss, say $1\frac{5}{8}$ per cent.

Tons, 101$\frac{15}{2000}$=202,300.81 lbs.=2,953,591.85 oz. Troy.
Average value per ounce, $2.18.

COST OF WORKING ORES.

Average cost of working 136,893$\frac{1222}{2000}$ tons ore, $11.74 per ton.

COST OF MINING.

Total cost of mining 137,180$\frac{930}{2000}$ tons of ore, including all cost of mining drifts, repairing shaft, &c., $8.63 per ton.

ASSETS.

Cash on hand May 1, 1873	$1,873,891 41
Rhode Island Mill	80,000 00
Mine improvements, buildings, &c	100,000 00
Real estate	15,000 00
Stock on hand at mine	58,287 49
Stock on hand at mill	9,596 26
Ore on hand at mill, 286$\frac{1640}{2000}$ tons	22,468 73
	2,294,243 89

LIABILITIES.

None.

Supplemental report, showing in detail the financial affairs of the company for past three years, from May 1, 1870, to May 1, 1873.

RECEIPTS.

Bullion:		
For year ending May 1, 1871	$472,181 48	
For year ending May 1, 1872	3,503,633 30	
For year ending May 1, 1873	6,442,785 02	
		$10,418,599 80

Premium on bullion:		
For year ending May 1, 1871	$474 92	
For year ending May 1, 1872	45 91	
		$520 83
Assessment:		
For year 1871, Nos. 20 and 21		78,000 00
Mine expense:		
For supplies, &c., year ending May 1, 1871	9,401 07	
For supplies, &c., year ending May 1, 1872	566 67	
For supplies, &c., year ending May 1, 1873	4,190 42	
		14,158 16
Rhode Island Mill:		
For year ending May 1, 1871	11,034 63	
For year ending May 1, 1872	783 69	
For year ending May 1, 1873	175 00	
		11,993 32
Sundry accounts:		
For year ending May 1, 1871	2,376 12	
For year ending May 1, 1872	931 35	
For year ending May 1, 1873	33 75	
		3,341 22
Cash in treasury May 1, 1870		39,309 08
Total		10,565,922 41

DISBURSEMENTS.

Mine expense:			
For labor, year ending 1871	$155,560 00		
For labor, year ending 1872	362,739 99		
For labor, year ending 1873	771,317 25		
		1,289,617 24	
For lumber, year ending 1871	28,974 21		
For lumber, year ending 1872	72,793 39		
For lumber, year ending 1873	175,522 07		
		277,289 67	
For wood, year ending 1871	35,281 11		
For wood, year ending 1872	50,262 85		
For wood, year ending 1873	66,858 33		
		152,402, 29	
For castings and supplies, year ending 1871	35,286 30		
For castings and supplies, year ending 1872	90,873 82		
For castings and supplies, year ending 1873	170,928 96		
		297,089 08	
			2,016,398 28
Mine improvement:			
For year ending 1871		250 00	
For year ending 1872		65,380 59	
For year ending 1873		16,280 77	
			81,911 36

Rhode Island Mill:			
For labor, year ending 1871..	$8,183 00		
For labor, year ending 1872..	30,907 88		
For labor, year ending 1873..	35,537 25		
		$74,628 13	
For wood, year ending 1871..	5,933 12		
For wood, year ending 1872..	29,778 25		
For wood, year ending 1873..	43,744 85		
		79,456 22	
Quicksilver castings, &c., 1871	17,136 04		
Quicksilver castings, &c., 1872	48,644 75		
Quicksilver castings, &c., 1873	65,107 22		
		130,888 01	
			$284,972 36
Rhode Island Mill improvements:			
For year ending May, 1871..............		3,565 32	
For year ending May, 1872..............		14,307 37	
			17,872 69
Outside mills:			
For crushing 18,903$\frac{1810}{2000}$ tons, 1871		191,149 93	
For crushing 67,222$\frac{630}{2000}$ tons, 1872		807,309 14	
For crushing 121,828$\frac{1480}{2000}$ tons, 1873		1,463,824 00	
			2,462,283 07
Dividends:			
For year ending May, 1872..............		1,260,000 00	
For year ending May, 1873..............		2,180,000 00	
			3,440,000 00
Legal expense:			
For year ending May 1, 1871............		1,450 00	
For year ending May 1, 1872............		8,400 00	
For year ending May 1, 1873............		6,957 65	
			16,807 65
Taxes:			
For year ending May 1, 1871............		4,008 27	
For year ending May 1, 1872............		18,454 22	
For year ending May 1, 1873............		42,429 00	
			64,891 49
General expense:			
For year ending May 1, 1871............		13,905 68	
For year ending May 1, 1872............		36,360 48	
For year ending May 1, 1873............		32,619 70	
			82,885 86
San Francisco expense:			
For year ending May 1, 1871............		9,802 48	
For year ending May 1, 1872............		9,171 25	
For year ending May 1, 1873............		10,514 52	
			29,488 25
Discount, (on bullion and drafts:)			
For year ending May 1, 1871............		1,562 57	
For year ending May 1, 1872............		2,803 15	
For year ending May 1, 1873............		86,745 36	
			91,111 08

Assaying:		
For year ending May 1, 1871	$3,664 00	
For year ending May 1, 1872	18,461 86	
For year ending May 1, 1873	26,561 20	
		$48,687 06
Treasure freight:		
For year ending May 1, 1871	1,913 03	
For year ending May 1, 1872	13,546 80	
For year ending May 1, 1873	22,212 58	
		37,672 41
Interest, (at Gold Hill:)		
For year ending May 1, 1871	492 97	
For year ending May 1, 1872	1,384 63	
For year ending May 1, 1873	1,855 64	
		3,733 24
Real estate:		
For year ending May 1, 1871	56 80	
For year ending May 1, 1872	468 25	
For year ending May 1, 1873	10,000 00	
		10,525 05
Assay-office:		
For year ending May 1, 1873		2,475 00
Sundry book accounts		316 15
Cash in treasury May 1, 1873		1,873,891 41
		10,565,922 41

ORE STATEMENT.

From May 1, 1870, *to May* 1, 1873.

$21,087\frac{600}{2000}$	tons worked for year ending May 1, 1871, yielded Average per ton, $22.39.	$472,121 81
$80,567\frac{680}{2000}$	tons worked for year ending May 1, 1872, yielded Average per ton, $43.48.	3,503,633 30
$136,893\frac{1290}{2000}$	tons worked for year ending May 1, 1873, yielded Average per ton, $47.05.	6,441,974 89
$238,548\frac{630}{2000}$		10,417,799 37

BULLION STATEMENT.

Stamped value of bullion as per assay certificates received at the office in San Francisco, from May 1, 1870, *to May* 1, 1873.

Value in gold	$4,581,284 01
Value in silver	5,880,899 59
Assay grains	54,744 67
Reclamations, &c	1,672 53
	10,418,599 80

Report of the Belcher for the year ending December 31, 1873.

The president, Mr. J. D. Fry, reports as follows:

While the prospects at the commencement of the year just closed justified the expectation that the product of the company's mine would be large, no one, I imagine, anticipated such unprecedented success as attended its operations, as shown by the superintendent's and secretary's reports, which are herewith submitted, and to which I refer you for all details relating to the mine and the company's finances.

It will be observed that the gross yield of the mine reached the sum of $10,779,171.09, and that $6,760,000 was paid the stockholders in dividends, and that a large surplus is carried forward. In addition to this it will be seen that a large amount was invested in supplies, which are on hand; also, that new machinery and improvements have been added.

The facilities are now nearly as perfect as they can be made for operating the mine, and the large reserves estimated by the superintendent, as well as the chances of more extended developments, render the outlook for good results during the incoming year very flattering.

The superintendent, Mr. W. H. Smith, reports:

During the year ending December 31, 1873, there have been extracted from the different levels of the mine 156,000 tons of ore, viz:

	Tons.
From the 1,000-foot level	40,000
From the 1,100-foot level	16,000
From the 1,200-foot level	40,000
From the 1,300-foot level	60,000
Total	156,000

The main incline has been sunk 380 feet, and stations have been opened at the 1,200-foot, 1,300-foot, and 1,400-foot levels. Connections have been made between the incline and ore-body on the 1,200-foot and 1,300-foot levels. On the 850-foot level the drift north from the east drift has been carried forward 100 feet through porphyry without having met with any favorable indications of ore. From the main north drift, 100 feet from north line, a cross-cut has been run to the east, through a formation of quartz and porphyry mixed, and from the end of this cross-cut a winze has been sunk (160 feet) to the 900-foot level and connected with the ore-body on the 1,000-foot level.

This winze was sunk for ventilating this portion of the mine, and also for running waste through in order to fill up the space from which ore has been extracted. On the 1,000-foot level the ore-body has been worked out 200 feet in length and 98 feet in height, and varying from 15 feet to 98 feet in width. This level continues to yield its usual quantity of good ore, and the prospects of its continuing to do so for some time to come are indeed good. It is almost next to an impossibility to make a correct estimate of the quantity of ore yet remaining on this level, as there has been no prospecting done above this level, except the drifts on the 850-foot level already mentioned. On the 1,100-foot level work was suspended in July, all the high-grade ore having been extracted. There still remains on this level from 10,000 to 15,000 tons of low-grade ore. A raise of 6 feet by 4 feet has been made from this level up to the 1,000-foot level, for the purpose of reaching the ore yet remaining in this portion of the mine. I am also running a drift west of the old workings on this level, which drift I consider of great necessity, as all the old openings on this level are rapidly closing up. The 1,200-foot level looks as promising as I have ever seen it, and, judging from the distance the sill-floor of this level and the sill-floor of the 1,100-foot level have been worked ahead of the breasts, it is my opinion that the product of this level for the next year will fully equal the past. A drift has been run on the sill-floor of this level, and, 50 feet from the north line, this drift has been continued 100 feet to the east, through low-grade ore. A cross-cut has also been made from the main south drift, (300 feet from north line,) which shows 12 feet of fair ore. Another cross-cut has been made east from the main incline, a distance of 150 feet, which shows hard porphyry all the way. The ore taken from the 1,300-foot level up to the present time has been hoisted through the Yellow-Jacket shaft. The main drift between the incline and ore-body has just been completed, and by the 10th of January will be in running order. A cross-cut 80 feet from north line has been run a distance of 100 feet to the east, through mixed quartz and porphyry, and on the fourth floor a drift has been run 120 feet to the east, as also on the ninth floor a drift has been run 47 feet to the east. Both of these drifts show about the same kind of ground as the cross-cut above mentioned. From the 1,200-foot level a winze has been sunk down to this level, which is 200 feet distant from the north line, and which shows good ore all the way. The ore yet remaining on this level will at least equal the amount already extracted from it, and prove to be quite as good.

From this level a winze, 60 feet from the north line, has been sunk down to the 1,400-foot level, and near the east wall of the ledge. From the bottom of this winze a cross-cut has been made, and 134 feet of drift has been run through very good ore. The appearance of this level, as far as it has been opened, is fully as good as any of the levels opened in the mine. I will commence mining on this level just as soon as the line between the Crown-Point and this company is fully established. Careful estimates of the quantity of ore yet remaining in the mine show that there are at least 150,000 tons. The openings to the mine and the appliances for its proper working are all in first-class order, and will compare favorably with any on the lead.

On the surface the following improvements have been made, viz: A switch and bridge from the railroad has been built for the purpose of receiving supplies for the mine; the ore-dump has been enlarged to double its former capacity; an addition has been made to the boiler-room large enough for four new boilers, which have been already set up; a complete set of machines, consisting of an engine, lathe, drill, and planer for repairing the machinery have been procured. Hence we are able to make any repairs which our machinery may require. A Burleigh air-compressor and two Burleigh drilling-machines have been added to the machinery, also 1,400 feet of 6-inch pipe have been put in, to convey the air from the compressors to these machines, making the most complete apparatus of the kind on this coast; all of which are a perfect success. A dwelling-house for the foreman of the mine has been built; four new safety-cages and one new safety incline-car have been constructed. We have also put in the mine one new engine for sinking winzes and hoisting waste wherever it may be required to fill up vacant space.

A summary of the labor performed in the mine during the year shows the extracting of 156,000 tons of ore, the running of 3,692 linear feet of drifts and winzes, the sinking of 380 feet of main incline, the laying of 4,072 feet of car-track, and other general repairs in and about the mine.

There is on hand at the mine and in Carson, of material and supplies, consisting of timber, lagging, wood, stone-coal, charcoal, iron, steel, candles, oils, &c., the equivalent of $142,337, as will be seen by the inventory of January 1, forwarded to the San Francisco office, as follows:

5,0-9 cords of wood, in Carson	$38,168 00
3,464 M timber, in Carson	65,816 00
Iron, steel, candles, &c	38,353 00
Total	142,337 00

In addition to this, there are, at the present time, in our ore-dumps and at the different mills, about 1,340 tons of ore, yet to be reduced, and which have been extracted during the year.

The secretary's report contains the following statements:

RECEIPTS.

Bullion	$10,779,171 07
Virginia and Truckee Railroad Company	2,117 24
Cash, January 1, 1873	1,011,124 11
Total	11,792,412 42

DISBURSEMENTS.

Crushing ores	$1,874,401 00
Labor	885,503 97
Mine expense	153,723 76
Discount on bullion	254,403 41
Hoisting ore, Yellow Jacket Company	66,653 00
Timber	193,031 36
Fuel, wood	79,517 28
Coal	44,526 83
Contracts on incline and drifts	52,466 33
Assays bullion	28,522 06
Assays ore, &c	9,906 79
Treasure freight	42,914 64
Supplies	44,680 90

Taxes on proceeds of mine		$83,582 41
Taxes, city, county, and State		4,082 55
Insurance		3,902 00
Legal expense		5,500 00
Construction		26,966 89
General expenses		14,430 22
Freight		8,676 06
Office expense		9,135 00
Exchange		8,407 00
Crown Point Gold and Silver Mining Company		137,500 00
Dividend Nos. 10 to 21, inclusive, $65 per share		6,760,000 00
W. H. Smith, cash	$19,804 86	
Cash January 1, 1874	980,165 10	
		999,969 96
Total		11,792,412 42

The following remarkable statement shows the dividends paid by the company in two years:

	1872.	1873.
January	$104,000	$312,000
February	156,000	312,000
March	156,000	416,000
April	206,000	520,000
May	312,000	832,000
June	312,000	1,040,000
July	312,000	832,000
August	312,000	728,000
September	312,000	520,000
October		312,000
November		416,000
December		520,000
Total	2,184,000	6,760,000

Cost of producing and reducing 154,664 *tons of ore.*

Labor	$885,503 97
Hoisting ore, Jacket Company	66,653 00
Supplies—hardware, tools, &c	108,750 00
Timber	116,250 00
Assays ores	9,906 79
General expense	14,430 22
Freight, supplies, &c	8,677 06
Wood and coal	85,876 11
Salaries and office expenses	21,835 00
	1,317,875 14

Equal per ton, $8.51.

Cost of crushing ore	$12 10
Cost of mining ore	8 51
Total	20 61

ORE STATEMENT.

Monthly account of ores reduced in 1873.

	No. tons.	Bullion.	Per ton.
January	8,501	$437,489 40	$51 46
February	10,417	730,013 87	70 08
March	12,008	888,393 39	73 98
April	15,981	1,184,475 62	74 11
May	18,965	1,500,823 81	79 13
June	13,074	914,592 19	69 95
July	13,685	912,781 15	66 70
August	10,483	691,758 93	65 99
September	9,876	647,709 62	65 58
October	12,825	831,262 83	64 82
November	13,702	940,195 75	68 81
December	15,147	1,099,674 48	72 60
Total	154,664	10,779,171 07	69 69

ORE STATEMENT FOR TWO YEARS AND FIVE MONTHS.

	Tons.	Per ton.	Bullion.	Dividends.
1871, five months	18,468	$64 93	$1,199,134 87	
1872	83,195	57 63	4,794,659 10	$2,184,000
1873	154,664	69 69	10,779,171 07	6,760,000
Total	256,327	65 40	16,772,965 04	8,944,000

Value in gold	$9,439,718 44
Value in silver	7,244,943 60
Assay grains	88,303 00
	16,772,965 04

BULLION STATEMENT.

Stamped value of bullion as per assay certificates:

Value in gold	$5,725,247 50
Value in silver	5,009,520 51
Assay grains	44,403 06
	10,779,171 07
Number ounces refined bullion	$4,173,535\frac{74}{100}$
Average fineness in gold	$.66\frac{1}{2}$
Average fineness in silver	.929
Value per ounce in gold	$\$1\ 37\frac{19}{100}$
Value per ounce in silver	$1\ 20\frac{2}{100}$
Value of bullion per ounce	$2\ 57\frac{21}{100}$
Average value per ton in gold	37 16
Average value per ton in silver	32 53
Total value per ton	69 69

Report of the Yellow Jacket for the year ending July 1, 1873.

The president, Mr. Thos. G. Taylor, reports:

The ore-production of the mine for the past year has been very light. But 1,918 tons of ore was mined, yielding $48,732.70, or an average of $25.40 per ton. The whole of this yield came from the old stope between the 900 and 1000 foot levels, and all work was suspended in these workings in the month of October last, on account of the exhaustion of the same, since which time there has been no ore produced by the mine. Consequently, the principal work done in the mine the past year has been dead work, or the prospecting for ore-bodies, and the retimbering and repairing of the shaft and drifts throughout the mine. There has been in all 4,212 feet of drifts run, and 560 feet of winzes sunk. All this work was done in hard ground, requiring the constant use of powder. We have retimbered, in a most substantial manner, 275 feet of our vertical shaft, 415 feet of our adit level, and several of the old stations in shaft. The improvements on the surface the past year consist in the entire reconstruction and change in position of our pumping-machinery, new bob and connection, spur-wheel, shaft and bearings, new foundations and anchorage for the same, new pump rods and plates—in fact, an entire change, with the exception of engine. We have on hand a good supply of spare steel-wire ropes for incline and vertical shaft, 300 feet of new pump column for shaft, and two new 54-inch boilers, with fixtures complete, which have not yet been placed in position. During the past year our expenses for fuel have been quite heavy, owing to the quantity of water we have had to contend with on the 1,400 and 1,500 foot levels, the latter being some 80 feet below the Sutro tunnel level, and 200 feet below the lowest levels of the adjoining mines. During the year we have made almost constant use of our Burleigh air-compressor, for the purpose of hoisting and pumping from the several winzes sunk, thereby being enabled to much sooner open and ventilate new levels for the speedy prospecting of the same. We have hoisted for the Belcher Silver-Mining Company 43,613 tons of ore, which has materially assisted to meet our disbursements. Our search for ore on the levels opened has been very thorough, but, unfortunately, unsuccessful. We still have fully a twelve-months' work to do on the 1,400 and 1,500 foot levels to thoroughly prospect them. In the mean time we are making preparations for the deeper exploration of the vein, which continues very regular in formation and dip, and contains between the walls, on the 1,400-foot level, where it has been cross-cut, upward of 250 feet of very favorable-looking vein-matter, and I am in hopes that at no distant day the company will be well repaid for its present outlay by the discovery of a paying ore-body. As a precaution against fire, we have ready for use, both in the hoisting-works and underground stations, a number of the Babcock fire-extinguishers, and our large tank, containing some 200,000 gallons of water, is kept constantly filled, and the hydrants and hose in constant readiness for use.

The secretary's report contains the following receipts and disbursements:

RECEIPTS.

Bullion proceeds, 1,918 tons ore, at $25.40	$48,732 70
Assessment No. 15	120,000 00
Belcher Silver-Mining Company, (hoisting-ore and supplies, &c.)	74,768 06
Confidence Silver-Mining Company, (for running drifts)	3,000 00
Sale of ropes, machinery, &c	4,050 98
Rent of storehouse and store	740 00
Advertising	332 50
Cash on hand July 1, 1872	194,456 42
Total	446,080 66

DISBURSEMENTS.

Crushing	$19,180 00
Labor	181,530 79
Salary	10,200 00
Assay-office	4,024 39

Taxes and insurance		$5,107 53
Expense		2,999 96
Lumber		20,585 33
Wood		43,663 77
Coal		27,098 59
Mine supplies		43,324 76
Powder and fuse		5,006 35
Candles and oil		4,701 00
Iron and steel		3,313 66
Improvements		30,073 12
Discount on bars		1,085 76
Assaying bars		157 76
Real estate		1,600 00
Legal expense		5,000 00
Cash on hand	$5,956 62	
Supplies on hand	31,471 27	
		37,427 89
Total		446,080 66

LANDER COUNTY.

Reese River district.—The Manhattan Silver-Mining Company has, as in former years, done the principal work in the district. During 1873 the company worked in its mill less ore than in the preceding year; but by far the greater quantity was from its own mines, while the amount of custom-ore worked was only half as large as in 1872. The following extracts from the report of the board of trustees for the year ending December 31, 1873, show the business and the condition of the financial affairs of the company:

EARNINGS.

From Oregon and North Star mines:			
2,287¼ tons ore, producing ($224.50 per ton)		$513,479 33	
Milling expenses	$80,049 39		
Mining expenses	179,016 80		
		259,066 19	
			$254,413 14
From other mines:			
696¾ tons ore, producing ($212.72 per ton)		148,212 33	
Milling expenses	24,382 00		
Mining expenses	95,669 67		
		120,051 67	
			28,160 66
Profit on custom-ores:			
1,674½ tons ore, ($27.74 per ton)			46,452 87
Total			329,026 67

Expense account:	
Freight of bullion to New York	$21,648 94
Discount and reclamations on bullion	32,009 02
Mill-repairs	8,397 64
Taxes	7,875 13
Exchange	4,999 91
Fire insurance	4,890 40

Interest	$5,483 28	
Expense	23,326 39	
Quicksilver lost	634 91	
Loss on slag from refining	3,578 42	
Depreciation of stable stock	605 50	
Loss on accident fund	2,238 83	
Sundry losses	238 11	
		$115,926 48
Earnings, coin		213,100 19

In September, 1873, the company paid a dividend of 5 per cent., or $19,375, and at the end of the year it was expected that another 5 per cent. dividend would be paid in the following April. The company carries a large surplus in cash and supplies.

For improvements of the mill and the hoisting-works at two of the mines the company has expended nearly $30,000 during the year. The North Star shaft was sunk 258 feet, (to 620 feet,) and the Oregon shaft, 107½ feet, (to 700 feet.) In the fore part of the year the results obtained by the company in their mill, or more particularly in their roasting-furnace, were reported not to be as satisfactory as they had been before; and the engagement of an experienced metallurgist was found necessary, for which position Mr. Alex. Trippel, of New York, was selected. So far as I can learn, the difficulties spoken of have been removed by him.

Besides the mines on Lander Hill, the Manhattan Company owns a number on Union Hill, south of Austin, and at Yankee Blade, a few miles north. Some of the latter are leased and produce fine ore.

The character of the Lander Hill ores is well known. The analysis given below will, however, be interesting as furnishing precise information. There is a general lack of iron pyrites in most of these ores. The Alida (or South American) and Oregon have the most, while the Savage has hardly any pyrites, but much manganese, occurring as carbonate (rose-spar) in layers in the vein-matter, parallel with the walls and pay-streak. The ore in mine is chiefly pyrargyrite, (dark ruby silver,) of which reasonably pure specimens have yielded 56 to 58 per cent. of silver. Beautiful crystals of stephanite grouped with quartz, stromeyerite, stetefeldtite, and altered fahlerz occur in the districts. Native silver is found at the Chase mine; chloride of silver, in all the mines near the surface; iodide, rarely, in the Oregon mine.

The Manhattan 20-stamp mill has been partly rebuilt, receiving a new battery with stamps of 930 instead of 750 pounds. The gain from the increased weight is doubtful. The principal improvement introduced is the separate conveyance of pulp from each set of five stamps to hoppers, whence it is fed at will by the Standish feeders into the main hopper above the Stetefeldt furnace. The furnace has been heightened 10 feet, and otherwise improved. The lack of pyrites in the ore is a great disadvantage in the treatment. The salt used is from Smoky Valley, containing 84 to 92 per cent. chloride of sodium, occasionally still less. The proportion added to the ore before roasting varies from 8 to 10 per cent, usually 9 per cent. The roasted ore is amalgamated in 8 pans, with as many settlers. Each pan is charged three times in twenty-four hours. Further details of operation may be found in the following admirable table, for which I am indebted to Mr. A. Trippel, metallurgist of the company:

Mine statistics 1873—*Manhattan Silver Mining Company.**

[For metallurgical statistics of this company see the chapter on metallurgy.]

Mine.	Nature of work done.	Number of days of contract work.	Value per day of contract work.	Number of feet.	Value per foot.	Per cent. of expenses.	Total expenses.	Tons of ore produced.	Assay value per ton.	Net value after milling.	Profit.	Loss.
Ogden	Contracts for stoping	928	$5 56	....	....	27.04	$5,166 79					
	Contracts for developing mine	1,037	3 66	506	$6 37	19.86	3,796 00					
	Day-labor	236	4 00	130	7 27	4.94	945 00					
	Running mine	537	4 83	....	....	14.50	2,770 00					
	Supplies and hauling	....	....	....	....	33.64	6,426 31					
						100.00	19,104 10	97 18-20	$195 60	$12,013 53	....	$7,090 57
South America	Contracts for stoping	93	3 66	....	....	0.82	313 03					
	Day-labor for stoping	849	4 00	....	....	8.89	3,398 50					
	Contracts for developing mine	2,266	3 87	1,288	6 81	22.99	8,778 37					
	Day-labor for developing mine	1,128	4 09	618	7 46	12.08	4,614 75					
	Running mine	1,332	4 27	....	....	14.9	5,691 67					
	Cost of hauling and supplies	....	....	....	....	40.32	15,402 62					
						100.00	38,198 94	203 18-20	144 04	21,646 23	....	16,552 69
Camargo	Contracts for developing mine	338	3 84	319	4 07	38.69	1,300 00					
	Day-labor for developing mine	84	4 00	96	3 50	10.00	336 00					
	Running mine	124	4 98	....	....	18.36	617 50					
	Cost of supplies and hauling	....	....	....	....	32.95	1,108 78					
						100.00	3,362 28	....	....	....	....	3,362 28
Isabella	Contracts for stoping	486	2 86	....	....	31.93	1,394 20					
	Contracts for developing mine	150	4 00	140	4 28	13.75	600 00					
	Running mine	70	4 90	....	....	7.86	342 99					
	Cost of supplies and hauling	....	....	....	....	46.46	2,026 41					
						100.00	4,363 60	18 40-200	231 25	2,754 78	....	1,608 82

Oregon	Contracts for stoping	5,884	6 58	......	......	24.09	38,733 84					
	Day-labor for stoping	5,374	4 00	......	......	13.37	21,497 00					
	Contracts for developing mine	4,485	3 82	3,008	5 71	10.66	17,138 53					
	Day-labor for developing mine	1,885	4 00	973	7 75	4.69	7,542 00					
	Running mine and sundries	7,505	4 48	......	......	21.10	33,914 99					
	Supplies, hauling, and official labor	......	......	......	......	26.09	41,957 89					
						100.00	160,784 25	1,538 11-20	218 14	216,431 67	$55,647 42	......
North Star	Contracts for stoping	424	3 06	......	......	2.92	1,300 40					
	Day-labor for stoping	2,381	4 27	......	......	23.26	10,172 00					
	Contracts for developing mine	601	4 05	375	6 50	5.75	2,437 50					
	Day-labor for developing mine	1,271	4 00	754	6 75	11.64	5,094 00					
	Running mine	1,762	4 46	......	......	17.94	7,850 59					
	Cost of supplies, hauling, and official labor	......	......	......	......	38.62	16,909 46					
						100.00	43,760 95	759 7-20	293 90	152,640 95	108,880 00	......
Morgan and Muncy	Contracts for stoping	531	7 49	......	......	68.3	5,503 78					
	Running mine	157	4 59	......	......	9.65	777 75					
	Supplies, hauling, and official labor	......	......	......	......	22.05	1,776 78					
						100.00	8,058 31	77 64-200	224 82	10,974 14	2,915 83	......
											167,443 25	28,614 36

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* In this statement the ore of each mine is charged with the usual rate for milling, taxes, discounts, as *custom ore*, and accepted at 80 and 82 per cent. of assay value.

Analyzed statistics of the Manhattan Mill, Austin, Nevada, 1873.

Month.	Ore reduced.	Salt consumed.	Average chlorination.	Average daily assay of raw ore, (mill test,) per ton.	Value of tailings per ton.	Amount in tailings.	Stetefeldt Furnace, average feed per minute.		Amalgam retorted.	Crude bullion from retorting.	Silver bars from crude bullion.	Loss in melting.	Proportion of assay value of ore obtained in the form of bullion.	Wood consumed.	Charcoal consumed.	Quicksilver consumed.	Average charge of pans.	Apparent loss or gains from comparison of bars and tailings with original ore-assays.
							Ore.	Salt.										
	Tons.	*Lbs.*	*Per ct.*	*Dolls.*	*Dolls.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per ct.*	*Per ct.*	*Cords.*	*Bush.*	*Lbs.*	*Lbs.*	*Per ct.*
January	504½	89,485	91.9	294 93	19 52	7.79	37.4	3¼	49,993	8,257	7,689	7.0	90.21	364	4,610	1,764	1,713	*2.17
February	238	48,162	92.9	245 70	17 87	8.26	38.0	3¾	27,061	4,419	4,288	3.0	92.70	101	2,000	833	1,227	†0.96
March	288	49,000	93.0	276 68	21 36	8.2	38.4	3	34,125	5,781	5,347	7.5	91.22	188	2,436	880	1,457	*0.57
April	410	66,400	91.69	253 12	16 07	6.6	39.2	3½	45,900	8,012	7,397	7.7	92.85	330	3,130	1,000	1,911	*0.54
May	607	91,000	88.53	250 14	22 31	8.91	38.7	3¼	60,025	9,853	9,065	8.0	90.16	380	5,080	1,306	1,690	*0.93
June	586	81,960	88.75	227 30	20 33	9.48	39.0	3¼	57,900	9,133	8,332	8.8	92.58	335	5,025	1,362	1,821	†2.06
July	438	63,696	89.0	206 27	21 25	9.6	38.4	3¼	37,950	6,213	5,703	8.4	91.38	302	2,150	1,138	....	Even.
August	535	80,585	88.8	170 97	16 86	9.86	38.0	3½	39,290	6,549	5,922	9.0	90.82	359	4,500	1,337	1,801	†0.63
September	543	76,095	86.4	212 00	26 64	12.86	37.1	3½	47,290	7,889	7,330	6.8	87.46	410	4,638	1,350	....	†0.32
October	509	63,104	87.2	287 18	28 19	9.06	37.0	3½	45,735	7,150	6,269	12.3	94.34	361	5,753	1,160	....	†4.3

* Loss. † Gain.

Manhattan Mill milling expenses, per ton of raw ore.

	Labor.	Fuel.	Supplies.	Quicksilver.	Salt.	Official labor.	Casting.	Hauling.	Average total.
1873.									
January	$10 04	$10 32	$1 71	$3 33	$3 28	$1 02	$1 94	$1 36	$33 00
February	11 34	10 94	2 20	3 35	3 28	2 00	2 36	1 74	37 21
March	11 86	9 50	2 27	3 05	2 69	1 65	2 60	2 12	35 76
April	8 45	10 84	2 28	2 44	2 56	1 16	2 46	1 88	32 07
May	8 16	9 14	1 96	2 25	3 37	97	2 05	1 17	28 09
June	8 17	8 75	1 89	2 32	2 21	1 00	1 99	98	27 31
July	8 40	9 13	2 05	2 65	2 64	1 22	1 67	1 33	29 09
August	8 84	10 03	2 08	2 75	2 52	92	1 56	1 10	29 80
September	8 92	11 11	2 23	2 74	2 98	88	1 64	94	31 44
October	9 53	11 47	1 90	2 67	2 73	93	1 65	98	31 85

Bullion production, Manhattan Mill.

	Ore.	Assay, value.	Per cent. obtained.	Shipped.
1873.	*Pounds.*			
January	1,009,000	$113,379 34	90.213	$102,283 24
February	476,000	58,260 00	92.709	54,012 74
March	576,000	78,101 32	91.222	71,245 61
April	820,000	103,800 00	92.851	96,379 65
May	1,214,000	148,533 23	90.163	133,942 23
June	1,172,000	137,782 10	92.585	127,566 20
July	876,000	95,980 00	91.385	87,711 98
August	1,070,000	90,400 00	90.820	82,101 39
September	1,086,000	115,700 00	87.463	101,247 58
October	1,018,000	141,050 00	94.346	133,075 80
Total	9,317,000	1,083,045 99	91.307	989,546 42

Analyses of silver bullion, Manhattan Mill, 1873–'74.

	June, bars.	July, bars.	Bar 4330.	January and February, 1874.
Silver	0.798	0.814	0.7395	0.6842
Copper	0.189	0.152	0.2239	0.2933
Lead	0.0068	0.0067	0.0180	0.0083
Antimony	0.0073	0.0105	0.0051	0.0069
Sulphur	Trace.	0.0020	0.0020	Trace.
Arsenic	Trace.	Trace.	Trace.	Trace.
Iron	0.0011	0.002	0.0013	0.0020
Slags	0.002	0.0036	0.0021	Trace.
Total	1.0042	0.9908	0.9919	0.9947

Analyses of average pulp samples from large lots.

	I. Oregon.	II. Savage.	II. South America.
Insoluble matter	84.523	75.100	86.117
Sulphur	2.820	2.221	4.340
Lead	2.681	0.231	0.528
Antimony	3.213	2.641	1.656
Copper	0.632	0.668	0.414
Arsenic	0.332	6.687	(*)
Iron	} 3.890	2.850	3.479
Manganese		5.200	2.131
Silver	1.448	0.690	0.274
Zinc	....	0.183	(*)
Total	99.509	96.491	98.939

* Not determined.

NOTE.—Lime, carbonic acid, and soluble alumina are not determined. The manganese exists chiefly as carbonate.

Assays of the ores from the following mines:

North Star	$287 43	$306 27	$251 36	$153 91
Oregon	117 79	174 35	546 66	
South America	233 26	155 47	164 14	160 22
Mohawk	290 57	232 48		
Isabella	171 99	182 20		
Dollarhide	150 77	99 73	818 42	
Pacific	128 79	910 29		
Ogden	431 96	126 46		
Florida	149 19	333 80		

These assays were from large lots, (pulp assays.)

The Pacific Mining Company, limited, after running in debt to the amount of about £2,500, was wound up by resolution of the shareholders at a meeting held in August, 1873, in London. It was, however, proposed that a new company should be formed by such of the shareholders as might be willing to buy in the property at the rate of the indebtedness of the company, and to provide a new working capital. The shaft of the mine was reported to have been sunk 150 feet deeper, but no levels had been driven in that entire distance. The superintendent of the mine thought that by driving the 550-foot level farther to the east, he could strike again a rich body of ore, and based his opinion upon the assertion, that another company, (the Manhattan,) which was working within 100 feet of the Pacific Company's boundary, was making a profit of about £4,000 per month, by the employment of twelve men. I am not informed whether the new company has really been organized. At all events there was no work done at the mine during the latter part of the year.

Battle Mountain district was annexed to Lander County, June, 1873. In Galena, the Avalanche mine was sold last summer, by the discoverers, to a New York company. The company has also bought several minor claims around the Avalanche, and extensions that might come in conflict with their possessory rights. A shaft has been sunk near the Avalanche ledge, about 70 feet deep, which has been provided with a pump and hoisting works. From the shaft a drift has been run toward the ledge. At the same time ore has been taken out of the other claims of the company in a small way and shipped to smelting-works. The ore is mostly argentiferous galena and the product of its decomposition. The company restricted its operations greatly after the eastern money crisis in the fall.

The Shilo and White mines, controlled by the White and Shilo Consolidated Mining Company, came to litigation with the Battle Mountain mine. A tunnel on the latter mine, run on its ledge, was approaching the White ledge, when a cross-cut drift was run toward the White. Before, however, actually going to law, a compromise was reached, under the terms of which the Battle Mountain mine was bought by the White and Shilo company. The White and Battle Mountain mines have been worked during most of the year by a few hands. The Shilo being lower down and having much water, has been worked little, the company having always a good supply of ore for their jiggers from the White. The principal ore is argentiferous galena, which carries zinc and crude iron pyrites and silver sulphates, mostly fahlore and ruby silver. The gangue, unlike that of any of the other ledges of the country, is a rock resembling gray-wacke; hardly any pure quartz is found. The ledge stands nearly vertical, dipping in places slightly to the east and others to the west. The works are not over 200 feet deep on the ledge. When extracted, the ore is carried by a tramway to a concentrating mill, a few hundred feet below in the same cañon, where it is crushed by a crusher and concentrated rather imperfectly in jiggers, and the concentrated stuff, assaying from $300 to $400 per ton, sacked and shipped to San Francisco. The tailings contain from $50 to $90 of silver per ton. The Trinity and Butte mines have been idle all the year. The companies that owned them having failed to work their ores to advantage, were not able to meet their engagements. The mines are now in the hands of parties who bought them at sheriff's sale.

The Buena Vista has been worked extensively, but no good strike is reported yet.

The Little Giant and Trenton mines have been undisturbed during the year.

In Copper Cañon the English company has been shipping a regular supply of copper-ore every month. But according to the directors' report for the year ending June 30, 1873, the quantity of ore raised during the fiscal year had fallen off fully 25 per cent. as compared with the yield of the previous year. Besides this, several shipments of ore, of which the directors had been advised at the date of the former report, had, upon their arrival in England, turned out to assay much less in copper than the San Francisco assay induced the managers to expect; and the prices obtained in England were lower than in the previous year. The case of 175 tons of copper-ore, shipped on the Adriatic, is especially cited as one carrying with it great disappointment. The average sample of this ore had assayed in San Francisco 26½ per cent. of copper, while the same ores assayed in England only 21⅜ per cent. This company has during the last year introduced Chinese labor at the mine, and so far the manager seems to be satisfied with the result. The directors report that at the close of the fiscal year the mine was in excellent condition for extended explorations, especially as it could now be worked by means of the new shaft, the construction of which had up to that time absorbed a considerable amount of the profits. The produce of the mine and the shipments from July 1, 1872, to June 30, 1873, were reported as follows:

	Sacks.	Tons.	Cwt.	Qrs.	Lbs.
Aug. 26, 1872, by Dauntless	1,422	72	11	0	5
by Frolic	1,500	78	5	2	2
by J. Nicholson	600	30	18	0	2
Oct. 16, 1872, by Carnarvon Castle	858	45	0	3	19
Nov. 11, 1872, by Sea Toller	1,032	55	15	0	20
Nov. 15, 1872, by Lockett	368	19	2	0	16
Dec. 31, 1872, by Van Dieman	1,772	91	5	3	1
Feb. 17, 1873, by Vancouver	1,693	82	5	1	1
by Birkley	939	49	19	1	4
Feb. 21, 1873, by Empress	2,269	119	5	2	7
Mar. 14, 1873, by Hermit	70	3	6	1	18
May 28, 1873, by Tantanon Castle	879	45	3	1	16
June 30, 1873, by waiting shipment	5,346	270	0	0	0
Total	18,658	962	18	1	27
Less waiting shipment, as per last report	2,322	120	4	2	9
Product of the year	16,336	842	13	3	18

The quantity of ore raised from the commencement of mining to the 30th June, 1873, is 3,303 tons, which has realized in England £58,980 gross.

Under date of October 24, 1873, the manager at the mines, Mr. J. Richards, reports that of late the ore supply in the stopes north of Hooper's rise had suddenly fallen off very considerably. The vein was here filled mostly with iron-ore, which contained only occasional small masses of copper-ore. As the miners had thus to drive through long stretches of worthless stuff, the cost of mining was ruinously increased.

No large body of ore was in sight at that time. The walls of the ledge were regular enough at all points, but there was very little copper-ore in the large mass of iron. Mr. Richards intended, therefore, to open up new ground; and, from the tenor of his report, seems to have had no expectations of meeting large ore-bodies for some time to come.

EUREKA COUNTY.

This is a new county organized during the year. The town of Eureka is the county-seat.

Eureka district.—The shipment of base bullion from this district in 1873 was $3,907,000. This large increase in the shipments of base bullion over that of last year ($2,495,033) indicates a prosperous state of the mining industry. But while heretofore the Eureka Consolidated Mining Company has been the foremost of the district, as far as extent and remunerative character of operations are concerned, the Richmond Consolidated has, during 1873, taken the lead. The Eureka Consolidated, though hardly less successful, financially, than in former years, has not been able to keep up in the race with the unparalleled strides the Richmond has made in the development of large and rich ore-bodies, and their rapid extraction and reduction. The Ruby Consolidated Company has also carried on its operations with gratifying results, though its balance-sheet cannot show the dividends of the larger companies. But it can boast of having earned all the money expended for improvements of the mining and smelting works, which were costly, and of having a fair surplus on hand.

The K K Consolidated has this year entered the list of largely-producing companies, though it has, so far, not had any smelting-works of its own. The large amount of bullion shipped by this company was produced entirely in the rented works of the Silver West Company—a company of which nothing was known last year. The Hoosac has worked the rich ores of the Hoosac mine, together with K K ore, during the greater part of the year. Its operations have been, as far as can be ascertained, financially successful.

The Richmond Consolidated Company still suffered during the first half of the year from the protracted lawsuit with the Eureka Consolidated Company which was mentioned in my last report. Upon the final disagreement of the jury, the Richmond thought it wisest to buy from the Eureka Company the disputed ground (the Lookout location) at the price proposed by the latter company, £17,000. The suit had meanwhile cost the two contending parties not less than $125,000, and there was every prospect of its indefinite continuance. During all the time the mine of the Richmond Company would have been virtually shut up, so that interest on the capital invested would also have been sacrificed. At the same time Mr. Clarence King, United States geologist, had reported to the company his estimate of the ore in sight in the Richmond mine, which was 87,000 tons, worth £757,000. Taking all this into consideration, it is clear that the directors of the Richmond acted wisely when they accepted the proffered compromise, and this conclusion is confirmed in the light of recent experience. The chairman of the annual meeting of the stockholders, held in London in November, 1873, informed the latter, with great satisfaction, in the course of his remarks, that Mr. King, in his report, had, in almost all cases, understated values, as was now apparent from the accounts of the workings, after the settlement with the Eureka Company. The value of the ore per ton, for instance, had been estimated at $40, while the accounts showed $53.35 as the average. The reserves, which Mr. King had put down as 87,000 tons, had been measured two months later, (during which time 12,000 to 14,000 tons had been raised,) by Professor Price, and 80,000 tons were found still standing. Ninety feet of shaft had been sunk in the Lizette tunnel, below the point at which Mr. King made his estimates, and it stood in solid ore of the same value as that above for the whole distance. And of all the explorations and developments, large as they were, none had so far touched the ground of the Tip-Top location, which still stood as almost virgin ground. In following the ore-body in the Lookout ground, it was found that it continued beyond the east boundary, and a new location of 1,500 feet, the "Silver Region," was here taken up by the company. It has not been explored to any considerable extent.

The total amount produced by the Richmond Company during the fiscal year was given, at the meeting of the stockholders above mentioned, as $842,000, of which $22,000 worth of ore was on hand at the beginning of the year, leaving $820,000 as the value of the ore raised and smelted. Of this £40,000, or $200,000, was profit, one-half of which was consumed in paying interest on debentures, in writing off the construction account, and as a reserve for the future. The balance was to go to the stockholders as a dividend. The cost for handling one ton of ore was given as $21, and the profit resulting as $18.

Mr. J. A. Porter, mining engineer, the assayer of the Richmond Company, has kindly furnished me with a *résumé* of the work done at the company's smelting-works during 1873.

The works of the Richmond Company were so fully described in the mining report of 1872, that it will only be necessary to mention the few additions that have since been made, in connection with the working results for the past year.

Two furnaces of 50 tons capacity have been in operation since the 15th of March. On the 9th of September a third, of the same capacity and dimensions, was completed. Owing to the baser nature of the ore new lining (sandstone) is required after a run of sixty days. The following table contains the working results for each month, from March 15, 1873, until January 1, 1874.

Production of bullion at the Richmond Works from March 15, 1873, *until January* 1, 1874, *with assay value of the same, estimate of coal consumed in smelting, &c.*

Date.	Tons of ore smelted.	Eureka assay of bullion.	Yield per ton of ore.	Bushels of coal consumed.	Bushels of coal per ton ore.	Pounds of bullion per ton ore.	Amount of ore to produce 1 ton of bullion.	†Pounds of bullion.
March 15-30	615	$34,156 52	$55 54	20,260	32⅞	325⅔	6 1-6	200,285
April..................	1,256⅔	62,051 77	49 38	39,636	31½	303 1-6	6⅗	380,929
May	2,232	130,793 93	58 60	80,244	36	395	5 1-15	881,640
June	2,135¼	135,287 51	63 36	73,612	34½	403½	5	861,573
	*1,211¾	64,826 85	53 50	....	....	331	6 1-22	401,089
July	2,493	139,391 28	55 91	82,900	33¼	345⅗	5¾	861,643
	*1,500	73,498 72	45 71	....	....	290	6 8-9	451,100
August	2,836⅓	144,861 16	51 03	85,537	30⅛	321¾	6¼	912,577
	*1,114 18-100	43,265 98	38 83	....	....	242	8¼	269,632
September	3,454	213,879 40	61 92	112,090	32½	407	4 9-10	1,405,778
	*436 1-10	30,799 52	70 63	....	....	465¾	4⅓	203,113
October	3,434¼	206,093 27	60 01	117,271	34 1-7	326¾	6⅛	1,122,141
November	4,082¾	235,658 26	57 71	133,144	32⅝	323	6 1-5	1,318,728
December	3,369¼	196,327 42	58 27	137,832	30½	315	6⅓	1,061,314
Total in year....	30,262 11-20	1,710,891 50	....	....	....	....	....	10,341,542

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* Richmond ore smelted by contract at Hoosac works.

† The last column in the above table has been calculated from the preceding columns—a method which involves some inaccuracy. The total does not agree with the statement made at the stockholders' meeting mentioned below, by the chairman, who gave the number of tons as 5,010. The discrepancy between these totals is too great to be referred to my method of calculation alone.

This product of over 5,000 tons of lead-bullion, with an assay-value of $1,710,891.59, obtained in only nine and a half months from $30,262\frac{11}{20}$ tons of ore, has never, to my knowledge, been equaled by any single lead-smelting works in this country.

It should be remarked here that the amount of coal, as given in the tabular statement above, includes only 8 per cent. of waste. The waste has since been estimated at 15 per cent., making the average consumption of coal per ton of ore 36 bushels. The net cash returns of bullion are about 77 per cent. of the assay value.

Estimated cost of working one ton of ore:

Mining expense	$5 00
Hauling to works	2 00
Smelting	17 00
	24 00

The loss in smelting is nearly 15 per cent. of gold and silver, and 19 per cent. of lead. This loss is divided between speiss (Fe As_3) and fumes. The slag, owing to excess of iron, being almost free from lead and silver, no matte ("Stein" of the Germans) is formed. About 5 per cent. of the total loss is contained in the speiss, the rest being carried off in so-called fumes, which are, however, principally unchanged ore, carried off by the force of the blast.

To avoid the latter loss, condensing-chambers, with underground canal, were being built in December. A calcining-furnace, to be used for removing dross from lead, was also under construction. A steam-engine of 40-horse power has been added to the works since my report of 1872.

According to the remarks of the chairman of a special stockholders' meeting, held toward the end of January, 1874, in London, the exact number of tons of lead-bullion produced from March 15 to December 31, 1873, by the Richmond works, was 5,010. The profit from the operations of the company during that time is reported to have been £120,000. From the same source it appears that the losses in silver and gold during the smelting operations have been very large, the chairman remarking that the average assay of the ores gave their value in the precious metals as about $70 per ton, while not over $52 per ton was extracted. This would be a loss of 25.7 per cent., ascertained to be correct by careful sampling of the ore as it went into the furnaces, and assays of the bullion produced during nine months. The principal cause of this heavy loss is said to be the fact that the Richmond ore rarely carries over 17 per cent. of lead. Further causes of loss are the large amount of dust now formed, and not saved, and the formation of speiss, which contains not less than $25 in gold and silver, but is all thrown over the dump.

The Eureka Consolidated Company has not raised as large a number of tons of ore as in the previous year, and has in fact at several periods during 1873 been compelled to expend large amounts for prospecting. But the business of the company has, nevertheless, according to the published reports, been more remunerative than in 1872. The company has had the misfortune of changing superintendents twice during the last year. The brief report of Mr. P. S. Buckminster, the superintendent in charge at the end of the official year, (September 30, 1873,) gives in outline the mining operations which had developed at least one large ore-body up to that time. The superintendent says:

> At the time of my taking charge of the business here (July 24, 1873,) there was an ore-body between the second and third levels from the Lawton shaft, which was not

of considerable magnitude, and has since been exhausted. Ore had just been found upon the fourth level, 300 feet from the surface, which has been continuously worked upon since, both in driving upon and extracting, and has, for a month past, improved both in grade and amount, until, at the present time, the promise is flattering for a very large body of excellent ore. It shows the most strength at the level-floor, which points to a strong continuation below. Am running prospecting drifts upon the second and third levels, and as yet have attained no very favorable results, but consider the promise sufficient to justify the necessary expenditure. Have recently commenced sinking the shaft for another level, as I believe the continuation of the ore-body of the fourth will be found upon a fifth level. At the Windsail shaft there was an ore-body being worked from the first level, which developed to a very fine ore, and extended to the surface, and which now appears to be nearly exhausted, but at one point we still have several feet of fine ore, which may extend and lead us to another extensive deposit. Between the first and second levels we have prospected very good ore, which increases in amount as we work upon it, and will, I think, furnish us a large amount of ore in the near future. Upon the second, am running prospecting drifts, which occasionally develop small amounts of ore, but as yet have not developed anything permanent. From the third level we have been extracting ore continuously, but to the present the body has not developed to considerable magnitude. There has been a fourth station opened from this shaft, and a drift run off a short distance, but the exigencies of mining and an abundance of unprospected ground nearer the surface, have prevented me, to the present, from re-opening it for continued exploration.

From the secretary's report for the official year ending September 30, 1873, I take the following items:

RECEIPTS.

For sales material, blower, horses, &c	$1,179,93	
For sales Lookout mine	85,000 00	
For reduction ores	3,107 50	
For product of 4,320* tons bullion refined	1,542,443 29	
Balance cash in hands of superintendent October 1, 1872.	1,713 98	
	1,633,444 70	
Balance overdraft Bank of California, October 1, 1873	3,558 17	
Balance overdraft bullion shipments October 1, 1873	171,310 81	
		$1,808,313,68

DISBURSEMENTS.

For construction and improvements	9,963 02	
Smelting account	344,919 86	
Mine account	291,794 03	
For general expenses Eureka	25,213 53	
For expenses San Francisco	8,634 38	
For interest	28,494 58	
For freight and refining, &c	289,511 25	
For bills payable	25,000 00	
For book accounts	8,374 72	
For superintendent's drafts	9,569 10	
For legal expenses	67,162 69	
For dividends	200,000 00	
		1,308,637 16
Balance overdraft Bank of California, October 1, 1872	169,327 94	
Balance overdraft bullion shipments, October 1, 1872	328,588 85	
		497,916 79
Balance cash in hands of superintendent, October 1, 1873.		1,759 73
		1,808,313 68

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*1,981 tons product of 1872.
2,339 tons product of 1873.

4,320 tons, refined in 1873.

RESOURCES.

P. S. Buckminster, superintendent	$1,759 73	
Supplies at Eureka, per inventory	14,606 71	
Charcoal on hand	9,908 00	
888 tons base bullion, product 1873, at refining-works and en route, approximate value	288,625 00	
		314,899 44

LIABILITIES.

Overdraft Bank of California	3,558 17	
Overdrafts bullion shipments	171,310 81	
Superintendent's drafts, not presented	15,613 43	
Book accounts not due	1,462 98	
Bills payable	50,000 00	
		241,945 39
Balance net resources, September 30, 1873		72,954 05

EARNINGS.

Product, 2,339 tons base bullion refined	878,787 77	
Value of 888 tons of base bullion at refining-works and en route	288,625 00	
Sale Lookout mine	85,000 00	
		$1,252,412 77

CURRENT EXPENSES.

Mine account	291,793 98	
Smelting account	344,919 81	
General expense Eureka	25,213 53	
Expense San Francisco	8,634 38	
Interest	28,494 58	
Legal expenses	67,162 69	
Freight and refining, &c	204,625 43	
Supplies and coal on hand, October 1, 1872	155,782 42	
	1,126,626 82	
Less supplies and coal now on hand, per inventory	24,514 71	
		1,102,112 11
Net earnings for 1873		150,300 66

Cost of extracting ores:

Expense of extracting and hauling to furnaces, 25,692 tons of ore	$291,794 03
Surplus on hand October 1, 1872	2,627 50
	294,421 53
Less supplies now on hand per inventory	6,962 09
	287,459 44

Or $11.18 per ton delivered at furnaces.

Cost of smelting ores:

Expenses of smelting 26,155 tons of ore	$344,919 86
Supplies on hand October 1, 1872	153,159 92
	498,079 78
Less coal and supplies now on hand per inventory	17,582 62
	480,527 16

Or $18.37 per ton.

26,155 tons of ore, reduced, produce 3,227 tons of base bullion, or 8.04 tons of ore produce 1 ton of bullion, at a cost of $237.66.

Transportation and refining charges, &c., aggregate about $78 per ton.

During the last month of 1873 reports reached me that the Eureka Consolidated Company had struck a large ore-body of far richer ore than it had heretofore possessed. It was found in the lowest workings of the mine; but I have not been able to get any particulars in regard to it.

In regard to the operations of the Ruby Consolidated Mining Company, I have again to thank Mr. O. H. Hahn, mining engineer, the superintendent of the works, for a very full and satisfactory report. Mr. Hahn writes at the end of the year:

> Herewith I send you the statistics in regard to our works. The result, which shows, as you see, a small cash profit, is only apparently unfavorable. You recollect that I had to work unproductive mines, as the Bullwhacker, Valentine, and Eldorado, with the profits from bought ore, and that at the same time I had to develop the heretofore neglected Dunderberg. In the general expenses given is included the cost of hoisting-works, &c. If this were not the case I would be able to show a far different result. Since October 1, I have been smelting almost exclusively Dunderberg ore, (which contains $50 in silver and gold and 20 per cent. of lead,) together with 30.4 per cent. slag, (41.1 tons ore with 12.5 tons basis slag,) using 39 bushels of coal per ton of ore. The expenses per ton of ore now are:

Mining and transportation of ore	$7 25
Smelting	16 00
General expenses	1 50
	24 75

> As you see from statement No. 2, I have, in calculating the value of the production, given the full value for gold and silver, assuming the ton of lead as worth only $10, in order to be on the safe side. Usually we have received from Balbach's refining-works, at Newark, the assay value in gold and silver, and $15 to $20 per ton of lead net, (after having deducted freight, commissions, and interest.)
>
> The rates of that refinery are:
> Assay value of silver less 5 ounces per ton.
> Assay value of gold less $2 per ton.
> 88 per cent. of the lead at 5¼ cents per pound.
> $20 currency charged per ton for refining.

Exhibit of the annual furnace production of the Ruby Consolidated Company in lead, compiled from the weekly reports of 1873.

Month.	Tons of ore.	Bushels charcoal.	No. of bars of lead produced.	Weight of bars in pounds.	No. of bars in shipments.	Weight of shipments.
January	1,042.3	48,988	3,954	351,579	4,163	370,890
April	981.1	32,391	3,203	283,279	3,040	268,924
May	1,263.9	41,202	4,577	410,835	4,657	417,318
June	1,553.07	55,550	5,238	471,962	5,099	458,892
July	2,282.1	77,070	6,193	559,486	6,458	583,659
August	1,376.6	42,770	3,904	360,114	3,919	353,768
September	721.0	22,830	1,798	162,340	1,823	165,061
October	1,768.6	63,999	6,689*	590,672*	6,689	590,481
November	1,690.3	60,509	6,245	530,808	6,247*	550,662*
December	423.3	17,850	1,307	118,448	1,149	104,102
	13,102.27	463,149	43,193	3,850,523	43,249	3,863,687
Deduct bullion left over from year 1872					214	19,251
					43,035	3,844,436
Add bullion produced 1873, shipped 1874					158	14,242
Total	13,102.27	463,149	43,193	3,850,523†	43,193	3,858,678†

* These items include 23 bars (2,060 pounds) sold at Eureka.

† The difference between these totals is the weight of the samples taken for assay.

Exhibit of the annual furnace production in gold and silver, compiled from the monthly reports of 1873.

Month.	Ounces silver.	Ounces gold.	Value of silver.	Value of gold.	Total.
January	25,713.02	315.80	$33,244 41	$6,546 96	$39,791 37
April	17,625.19	379.21	22,787 63	7,840 46	30,628 09
May	29,465.19	502.22	38,104 99	10,385 42	48,490 41
June	39,033.50	675.01	50,889 43	13,997 03	64,886 46
July	45,872.14	1,010.10	59,314 86	21,096 32	80,411 18
August	28,218.33	579.59	36,482 19	12,113 21	48,595 40
September	13,924.37	315.81	18,003 11	6,528 33	24,531 44
October	30,830.72	664.84	39,856 80	17,879 84	57,736 64
November	27,058.89	916.43	34,983 91	19,013 03	53,996 94
December	4,942.12	169.93	6,388 60	3,512 50	9,901 10
	262,683.56	5,728.94	340,055 91	118 913 10	458,969 02
Left over from 1872	1,095.37	18.20	1,416 26	377 42	1,793 68
	261,588.19	5,710.74	338,639 65	118,535 68	457,175 34
To be added on 1873 account	687.74	30.24	889 06	625 08	1,514 14
Total production	262,275.93	5,740.98	339,528 71	119,160 76	458,689 48

The ore smelted came from the following sources:

	Tons.
From the company's mines	4,818.4
From the K. K. Consolidated Company's mines	7,298
From varions other mines	985.87
Total	13,102.27

In the amount of charcoal consumed, 463,149 bushels, the waste is not included, but very full data in regard to it are given below.

The total yield in bullion was, according to the above tables 3,859,523 pounds = 1,929.7615 tons.

Number of working-days, 318½.

Number of furnaces, 2.

Yield in—

Gold, 5,740.98 ounces	$119,160 76
Silver, 262,275.93 ounces	339,528 71
Total	458,689 47

The assay value per ton of bullion was:

Gold, 2.975 ounces	$61 75
Silver, 135.91 ounces	175 94
Total	237 69

The cost for treating one ton of ore was:

For mining and hauling	$6 34
For general expenses and purchase of ore	11 17
For reduction	15 63
	33 14

From the preceding figures the following are deduced:

Average quantity of ore smelted in one furnace per day, 41.1 tons.

Average quantity of coal used per furnace, in 24 hours, 1,454 bushels.

Average quantity of bullion produced in 24 hours, 6.06 tons.

Average quantity of ore required to make 1 ton of bullion, 6.79 tons.
Average consumption of charcoal per ton of ore, 35.3 bushels.

The economical result of the year, as far as cash profits are concerned, is expressed in the following:

Value of silver and gold produced	$458,689 47
Net value of lead, at $10 per ton	19,297 61
Value of total product	477,987 08
Total expenses	434,209 22
Total cash profit	43,777 86

In order to arrive at the correct percentage of charcoal lost in handling, which of course should be entered in the expense account of the smelting-works, Mr. Hahn has compared the amounts of coal purchased, handled, and consumed, from the time the works of the Ruby Consolidated Company were started, in November, 1872, up to the third week in January, 1874. He arrived at the following figures:

	Bushels.
Purchased	574,413
Conveyed to bins at furnaces	524,893
Consumed according to tally-board	518,550

The loss of coal in conveying from bulkhead to furnace bins is therefore	8.62 per cent.
Loss in conveying from bins to furnaces	1.1 per cent.
Total loss	9.72 per cent.

The coal purchased comprises that used in the assay-office, blacksmith-shop, that used at the mines and some very small lots sold. The total number of tons of ore reduced from the day of starting to the time mentioned above, was 15.439.77. There was therefore used an average of 37.2 bushels of purchased coal per ton of ore, of which only 33.6 bushels went actually into the furnaces. The proportion of hard-smelting to self-fluxing ores (such as K K) has been about 1.1. The loss in money-value by waste of charcoal has been 574,413—518,550=55,863 bushels, at 30 cents, $16,758.90, or $1.08 per ton of ore smelted.

This will appear a large loss to those who have never looked closely into the real expenses of smelting-works, but such as have the necessary experience will be satisfied that it is far below the average at western works.

In order to diminish the actual loss of money as much as possible, Mr. Hahn provided his boilers in the fall with the grates known as "Müller's Heizpult," on which he burns the charcoal-waste effectually. These grates are formed of iron plates, slightly inclined inward, and perforated with small holes. Under these plates wind of a low pressure is introduced, and it is thus possible to burn fuel of very small size perfectly and with the best effect.

The K K Consolidated Company, under the experienced management of W. S. Keyes, mining engineer, has developed its mines splendidly. Mr. Keyes mined a large amount of ore, which was partly sold to various smelting-works, and partly smelted in a furnace leased of the Silver West Company. The K K Company has bought up numerous claims, conflicting with their own, during the year, and has paid $62,500 dividends to its stockholders. Besides this it has expended about $40,000 for improvements. I am indebted to the courtesy of Mr. Keyes for the following statement of the operations of the company:

Number of tons smelted during the year		$9,469\frac{182}{2000}$
Number of tons of lead-bullion produced		$1,311\frac{718}{2000}$
Estimated average gross value per ton		$300 00
Estimated total value		$393,407 70
Number of tons of ore sold:		
3,207 tons first class, at $20	$64,140 00	
655 tons second class, at $10	6,550 00	
3,840 tons third class, at $5	19,200 00	
		89,890 00
7,702 tons sold.		
$9,469\frac{182}{2000}$ tons smelted.		
$17,171\frac{182}{2000}$ tons mined, with a total value of		483,297 70

There was, therefore, realized from every ton mined a little over $28.

Mr. Keyes estimates the cost of mining and hauling per ton at	$8 00
Cost of smelting	18 00
Total cost per ton	26 00

The Hoosac Company has not furnished me with a report, because the manager does not wish to make the value of the company's mine public until the present litigation is finished. After that full data are promised for a subsequent report.

I can only say in regard to this company that its ores were sold to the other smelting companies in Eureka up to October, 1873, and that the product from the same is therefore included in the statements of those companies. From that time on the company had their one furnace (capacity, 50 tons of ore in 24 hours) running pretty regularly. I estimate that during the period the Hoosac Company produced about 500 tons of bullion of a value of about $300 per ton.

At Eureka there are now the following beneficiating establishments:

	Shaft-furnaces.
Eureka Consolidated Company	5
Richmond Consolidated Company	3*
Ruby Consolidated Company	2
Silver West Consolidated Company	1
Hoosac Mining Company	1
Jackson Silver-Mining Company	2
Eureka Mining and Smelting Company	2
Roslin Smelting Works	1
	17

The first three works have treated their own ore; at the Silver West furnace only K K ore has been smelted; the Hoosac Company has smelted its own ore, Richmond and K K ore, and the Jackson furnaces have also smelted K K ore. The Eureka Mining and Smelting Company and the Roslin Works have been idle.

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*And one softening-furnace.

Besides the above there is at Eureka the Lemon Mill, with 15 stamps and a White's roasting-furnace, which was mentioned in last year's report. The mill was working only a very short time. There is also a small 5-stamp mill at Eureka, which has been altogether idle.

The mines of the Lemon Company, of which the Lemon on the eastern and the Laurel on the western slope of Prospect Mountain are the principal ones, present a very interesting geological occurrence, showing to what an enormous denudation the mountain-range has been subjected. The main ridge of Prospect Mountain descends northward, from the highest point of the mountain on the south, for a distance of about one mile, when the ridge begins to sink rapidly and tapers out at last into a plain, stretching far to the north. Both the east and west declivities of the highest part of the ridge are found covered, immediately below the surface detritus, with what are undoubtedly the *debris* of a mineral vein or deposit, lying immediately on the lime-rock, of which the mountain here consists. Whether the deposit now covering the flanks of the mountain, and extending in some places to the top, is composed of *débris in place*, (which is possible, as an anticlinal runs nearly along the ridge,) or whether it has been washed to its present position from exposed parts of an earlier deposit (as, for example, the outcrop of a vein or mass on what was once the top of the mountain) is not yet determined. It is certain, that in the latter case the deposit must have been a very large one, or denudation must have been extremely extensive and prolonged. At all events no "mother-lode" has yet been discovered that accounts for the phenomenon.

The work done on the two mountain sides so far consists of several shafts sunk and tunnels driven by the Lemon Company and many tunnels and open cuts by other parties. All these openings have sooner or later penetrated through the ore-bearing matter and run against the limestone. One tunnel, driven by the Lemon Company, has penetrated into the limestone for several hundred feet, and, being started on the theory that a vein running parallel with the axis of the mountain exists somewhere ahead of it, it is intended to continue until the main vein or deposit is reached. If it should be continued a reasonable distance beyond the line of the present ridge of the mountain, it will at all events throw light on the question of the origin of the layer of mineral. The latter is, on the eastern slope, of a yellow and ochereous substance near the surface. Immediately on the limestone, however, the same mass contains much quartz, in the shape of small angular pieces, most of which are less than one-fourth of an inch in diameter. The whole mass contains rarely more than 5 to 8 per cent. of lead, but is far richer in gold and silver than other ores of the district. The quartzose, breccia-like portions are the richest in gold. On the western slope of the mountain a part of the ore has a red color and is softer than that on the eastern slope; other parts resemble the brown outcrop of ferruginous lead-lodes; and still others coincide in color and appearance with the ochereous ore first mentioned. All of it is siliceous and rich in the precious metals.

The proper way, it seems, to find the problematical vein or lode, would be to follow the ore-deposit immediately on the limestone, upward toward the top of the mountain, and to examine closely the bottom of the drifts as they advance. The top of a lode or deposit would thus be certain to be found, if it existed.

The production of Eureka district during the year 1873 was as follows:

Name of company.	Tons of base bullion.	Value in gold and silver.
Richmond Consolidated Company	5,010	$1,710,891 59
Eureka Consolidated Company	*3,302	*1,194,412 77
Ruby Consolidated Company	1,929	458,689 48
K K Consolidated Company	1,311	393,407 70
Hoosac Mining and Smelting Company	*500	*150,000 00
Total	12,052	3,907,401 54

* Estimated.

In *Pinto district*, the 20-stamp mill with Stetefeldt furnace, belonging to the Basye Company, is still idle. The company has not had any better fortune than last year.

Diamond district is located about twenty-five miles north of Eureka. Here the Champion Silver-Mining Company has built a shaft-furnace. But after a few ineffectual attempts to smelt the quartzose silver-lead ores of that district, the work was abandoned, and the furnace fell into the hands of the sheriff.

Mineral Hill district.—The mines of the English Company, which was mentioned in my last report as having failed, were worked during part of the year for the benefit of the debenture-holders of the property. But the ore-supply was very variable and no satisfactory results have been reached. What little ore has been found was worked by amalgamation with the aid of chemicals, the use of the Stetefeldt roasting-furnace having been abandoned on account of the irregular supply of the ores and for various other reasons.

HUMBOLDT COUNTY.

As in the preceding years, I have to acknowledge my indebtedness, for the principal part of the report on Humboldt County, to D. Van Lennep, mining engineer, of Unionville, whose position in the county has enabled him to watch mining operations during the year closely, and who is qualified, by a thorough local knowledge as well as a scientific and professional training, to be a most competent observer.

In taking a retrospective view of the year just closed, it must be acknowledged that mining operations have been struggling hard, but that they have, nevertheless, made some improvement. The progress in the reduction of silver by roasting the ores in drop-furnaces has not thus far proved so successful as to give entire satisfaction. There is a failure to be recorded in roasting thoroughly some kinds of ores, caused either by want of experience or by defects in the furnaces. The Meadow Valley process of reducing base ores by means of chemicals in the pans has not yet obtained a good footing. Failures, or at best only partial success, have been frequent for want of scientific knowledge and on account of the presence of base metals in the ores.

Buena Vista district.—The Arizona, the only paying mine of the district, has been worked steadily all the year, but with a smaller force than in 1872. The number of tons extracted during the year 1873 was 3,915, of which 3,834 tons were reduced by the mills of the company owning the mine, and 81 tons shipped to San Francisco, the latter realizing $26,855.18, or about $331.50 per ton. The actual yield per ton from the milled ores is not easily got at, as tailings are worked at the same time.

The price paid for wages is the same as a year ago. The ore has been taken out mostly: First, from the stopes on the east and below the western main tunnel all along the same, but mostly near the south end. In this place the ledge has been followed for about 100 feet, dipping eastward and at about 20 degrees, then for about 200 feet in a nearly level position, only slight waves up and down having been encountered. Second, from the Stewart ledge above the eastern tunnel; that is, from all the space not yet exhausted between the same and the extension of the upper tunnel, and about 300 feet farther in the hill. Third, from the eastern spur, so called. This was reached from outside by running a tunnel about 225 feet east of the main tunnel. This spur has been followed for about 100 feet east of the tunnel, when it rises and terminates in a wedge. Fourth, from old stopes on the western side and above the western main or Falls tunnel. The ledge on this side has been stoped out to a break that crosses the ledge diagonally. At a point about 260 feet south of the forking of the two tunnels, and westward in the western main tunnel, the break was followed for about 50 feet by an incline, when the ledge was reached and followed for about 70 feet, but it was abandoned at that point on account of water coming into the drift. During the year a western drift was run about 270 feet farther in the main tunnel, westward, in the country rock, for about 200 feet; thence, changing its course, it was run to reach the end of the drift run in the incline. Thus the ledge has been reached beyond the break by level drifts. The ledge at this place is small but good, with the prospect of much good ground to work on in the future. The two main tunnels, that is, the western on Fall's Ledge, so called, and the eastern on Stewart's Ledge, were not extended during the year.

The three mills belonging to the company have undergone some changes during the year. The Silver Mill was, in the fall of the year, changed to a tailings-mill. The stamps were removed, and additional pans and settlers were put in. It has now two large Wheeler pans, one McCone pan, and four Varney pans. The additional pans were brought from the Essex Mill at Dun Glen. It is the intention to work the tailings that have accumulated around the mill and those in the other reservoir of the company. The Tailings Mill has not been changed; its water-power was utilized by a turbine; a hurdy-gurdy, so called, on this coast, or a tangential turbine, has been put in its place. The Akin furnace built close to it, to roast tailings, has not been run, and was demolished during the year. The Arizona Mill was enlarged in the fall; its battery was taken down and replaced by that of the Silver Mill, and room for another 10-stamp battery was provided for, but as yet the battery has not been put up. Additional pans were put in. The mill has now four large and two small Wheeler and two Varney pans. It works both rock and tailings. The Arizona Association, owning the Arizona mine and property belonging to it, was incorporated in San Francisco last November, under the name of the Arizona Silver-Mining Company, and the new administration commenced its work before the end of the year. The Henning mine was worked for about three months, in the beginning of the year, by the Pioneer and Inskip Mining and Milling Company. The ledge lies nearly horizontal. Two tunnels have been run in the hill, which are connected by stopings and drifts. The farthest point reached in the hill is about 250 feet from the mouth of the main tunnel. The ground between the tunnels has been partly stoped out and tested in the mill of the company. After the usual assorting on the dump, the rock assays from $30 to $35, of which about 60 per cent. was extracted by the mill. There being a financial loss in the operation, the company discontinued working the mine, which was then leased to Cornish miners, who tried it for one month and gave it up, after which the whole property was leased for one year. The mine was again tried and abandoned. It needs the courage and capital of Pacific miners to prospect farther in the hill to ascertain the value of the mine. The Pioneer Mill has not been altered during the year, and has been worked all the year, partly on Henning ore, but mostly on tailings belonging to the company.

There has been a new discovery, during the fall, on the hill about three-quarters of a mile south of the Arizona mine, called the "Millionaire." It is a nearly flat ledge, in calcareous slate. As far as prospected the ledge opens well, and some rich ore is found in streaks.

On the Sugar Pine, an extension of the Arizona, some work has been done and prospects are good.

Considerable work has also been done on the Peru ledge, in a gulch east of the Arizona mine. A shaft about 70 feet deep has been sunk on the ledge. In the main or right-hand drift, in the upper works, a good deal of mineral has been taken out. A few tons tried at the Pioneer Mill assayed $40. The owners are still at work on it, hoping to make a better strike.

Indian district.—The Eagle mine, owned by J. B. Walker, an old settler in the district, and his partner, has been sold to an Oakland, California, company. About $2,000 has been paid, and the balance, the amount of which is not known, will be paid at the beginning of 1874, when the company will take possession. The ledge carries mostly gold. The report is that the company will put up a 10-stamp mill during the year.

On the same belt, about a mile north, two miners have discovered a ledge, which they have been working for several months. An extension has also been found, and has been worked by two miners for about a month, with good prospects.

In *Sacramento district*, on the west side of the range, two miners have worked a ledge of iron pyrites containing gold. They have extracted some of the gold by working the ore in a rude way with an arrastra built by themselves. These prospectors are expecting the erection of a quartz-mill for the Eagle mine as the practicable way of testing the worth of their mines.

The smelting-works at Oreana have been idle all the year. A 5-stamp mill, worked by a water-wheel, which is driven by the current of the Humboldt River, has been running at favorable times during the year on the ores of mines in the Trinity district, worked in a small way by Mr. Torrey, the owner of the mill.

In *Relief district*, the Batavia and Pacific mine has been worked with but little interruption. The ledge is irregular in its yield, but large. At certain intervals bodies of ore are reached. The richest is sent to the San Francisco market, the poorer is milled at Batavia Mill, about three miles from the mine. The mill has five stamps and has been kept going the larger part of the year. When no rock is to be had from the mine, the tailings are worked over. No other claims have been developed enough during the year to entitle them to mention.

Bolivia district is partly in Humboldt and partly in Churchill Counties. It lies southeast of Relief district. Its rich copper-mines have attracted a good deal of attention; but the distance to the railroad is a great drawback to its development. The nearest railroad station, Oreana, is about thirty miles distant. Parties interested in the mines are opening a road from Austin to Oreana, through the district. The distance from Oreana to Austin is about the same as from Battle Mountain to the same place, but the new road will have the advantage of saving many miles of railroad travel to goods and passengers from the west. With regular freight-wagons on the road, the ores of the district could be shipped to the railroad at comparatively cheap rates. The mine most spoken of is the Tidal Wave. It has a deep shaft sunk on the ledge, showing solid mineral. It yields a variety of copper-ores, but most of it is gray copper-ore. Two other mines have been worked during the year.

In *Central district* there have been more new discoveries during the past year than in any other part of the county. The ledges are small but carry rich ores. The Marietta has been worked with a few hands throughout the year. It was sold by the discoverers at the end of the year to a Virginia City capitalist. The ore has been worked at Winnemucca, and at the mill in the district. Milling-ore yields about $40, about $10 of which is gold. The Teamster's ledge has also been worked during the year, and the ore treated at the mill of the district. The assay value is from $40 to $45, of which about $20 is gold. Of this value about 70 per cent. was extracted at the mill. The mill, known as Philip Muller's, has four stamps and one large Wheeler pan. A drop furnace, constructed on a design of Philip Muller's, is used to roast the ore before amalgamating; about 70 per cent., on an average, is chloridized. The controlling interest in the mill has lately been purchased by a Virginia City capitalist, and with improved facilities greater activity is expected in the future. The Dutchman mine was discovered in the summer. The ledge is about a foot thick, and the average assay value of the ore is $100 per ton. Rich samples assay from $2,500 to $3,000 per ton. Several other ledges with good mineral have been discovered, but so far little work has been done on them.

In *Sierra district*, the Cresopolis was worked during a large portion of the year by four men. The ore extracted was shipped to Winnemucca Mill for reduction. A light force has also been at work on the Gem mine, and small quantities of ore have been shipped to Winnemucca and to San Francisco.

A gold ledge near and northwest of the Gem was tested in the summer. About five tons were extracted and worked at the Winnemucca Mill. It assayed $58 per ton.

The Dallulah mine has been idle most of the year. Some ore was extracted from the upper and old works, assorted into first and second class, and reduced at Winnemucca. The first class assayed $550, the second class $140. The lower tunnel is about 800 feet in the hill; at that distance a small seam of barren quartz was reached, but soon abandoned.

The Paul Mill in Dun Glen has been attached for the debts of the company controlling it, and will probably come under the sheriff's hammer. It has been idle most of the year. The superintendent claims that the gold-ores worked by the mill yielded over 90 per cent. of their assay value, and that the electric settlers saved every particle of quicksilver that ran over the first settler.

The Essex Mill, at the same place, has been idle all the year; in the fall it was sold, torn down, and carried to Unionville. Most of its machinery is to be placed in the mills at the latter place.

In *Winnemucca district* the two gold ledges have been worked in a small way, during a part of the year, and the ores have been reduced at the Humboldt Canal reduction-works. These works have been in operation during the greater part of the year, on the ores of different districts in this and other counties. The report is that the enterprise is not as successful as was anticipated. Some ores are worked closely, but of others a large per cent. is left in the tailings. The suit brought last August against the company by the Stetefeldt Furnace Company, was decided in the latter company's favor. A compromise was soon agreed upon, so that the works did not suffer from stoppage.

Gold Run district is reviving again. The old mill had last year been "jumped" by parties who bought the land of the railroad company. The mill was sold for old iron, and the land purchased by Mr. G. W. Holt, who has erected a new mill to work the tailings on the ground, and the ores available for milling in the district. The new mill has 5 stamps and 2 pans. It has an engine and a hurdy-gurdy wheel, so as to run the machinery by water in the favorable seasons.

The old Golconda mine has come back into the hands of its former owners, in whose favor the lawsuit brought against the parties who "jumped" it was decided. Since last summer the extension of the Golconda mine has been worked by parties who purchased it. The ore will be worked at Holt's Mill as soon as favorable weather sets in.

The Gregg mine, four or five miles south of the Golconda, has been worked all the year with a few hands. The richest part of the ore is selected and mostly shipped to San Francisco. It runs about $500 per ton.

In *Humboldt district* some parties have been prospecting old claims.

In *Echo district*, the Butte mine and mill at Rye Patch were bought by the Rye Patch Mining Company of San Francisco. The mine has been worked steadily with a full force of about forty men. The Stetefeldt furnace could not be run to advantage by the new administration. The ore is now worked in the raw way, in pans, and about 70 per cent. of the silver is extracted. The company has had its surplus rock worked at the Winnemucca Mill; at times having ten tons a day shipped there.

Star district.—During the year new life has been imparted to this district by the erection of a Krom concentrating-mill. About three years ago, when the Sheba mine came into the hands of Mr. Fall, of Unionville, he found a great amount of low-grade ore on the dump, which had accumulated from spalling and assorting the shipping-ore. He conceived the idea of concentrating it; and for this purpose built a water-wheel and a fine battery of stamps just below the dump. He also sent a skillful wheelwright and mill-man to Grass Valley, California, highly spoken of on the Pacific coast for its success in concentrating sulphurets containing gold, to examine the machines in use there and the various modes of concentrating, in order to reproduce the same at Star City. This was done faithfully. The silver minerals in the ore, however, proved to be too light or else broke in too unfavorable a manner for the use of water in concentration. At any rate, most of the silver in the ore which was crushed fine floated away with the water. The tailings consisted principally of quartz, and assayed about $10 per ton. All that was claimed to have been saved in the concentration was about 40 per cent. of the contents of the ore. Some of the richest parts of the ore were light enough to float even out of the tailings-reservior. In consequence of this experience, dressing by water was abandoned. The five stamps were bought by Mr. Holt, and carried to Gold Run district in the fall of this year. Mr. T. G. Negus, of Unionville, having, during a visit to the Eastern States, examined the Krom concentrator, and thinking it well adapted to concentrate the Star district ores, induced some of his friends who had interests in the county to try the experiment.

These gentlemen having secured the right of the Krom concentrator for this State, formed a company under the name of the Krom Concentrating Company. Near the close of the year 1872 the company sent plans and the requirements necessary to build an establishment in Star district suited to receive the machinery of a Krom concentrating-works. Mr. Negus put up a substantial building according to the plans sent, and in the spring of 1873 the machinery was readily put up. A tangential turbine-wheel, 8 feet in diameter, was put up, to which the water was brought from the cañon in a sheet-iron pipe 1,300 feet long, the fall being 230 feet. As the stream is not large enough during the dry season to furnish water all the time, a dam has been placed, at the upper end of the pipe, across the cañon, so that by collecting the water the mill can be run for several hours each day. Mr. Krom himself was on the spot at the completion of the mill and during the beginning of work, in order to secure by his personal superintendence as perfect a concentration as possible. As the mill stands now, the machinery in every particular appears to be excellently arranged and works well. The building has four floors. Behind it, on a level with the third floor, the ore is brought and dumped. At a short distance inside the building is a Blake crusher, into which the ore is fed. The crushed ore drops on a first pair of rollers and thence on a second. In coming out of the second rollers the ore drops on an elevator under the first floor of the building. This elevator carries the crushed ore up to the highest part of the building, and thence it is dropped successively through three revolving screens placed one over the other. There are three sizes obtained by these screens, and each size is dropped in a separate bin or hopper below on the third floor; thence it is conveyed into Krom concentrators placed below on the second floor. There are two concentrators to each bin. The two must run at full speed to pass through all the ore without crowding. After going out of these concentrators, the now partly-concentrated ore drops down on three other concentrators on the first floor.

There are thus three sizes that come out of these concentrators, the coarse, the middle size, and the fine. They vary in value and quantity according to the brittleness and nature of the minerals in the ore. Besides these products there is a small portion of fine material that comes out of the 100-mesh screen which does not go through the concentrator, and which is about three times as rich as the original ore. The dust gathered in the dust-chamber has about the same value as the fine stuff just mentioned.

To gather the dust produced by the several operations and flying up from the machines, 8-inch pipes, opening like funnels, are placed just above the breaker and each of the rollers, as well as above each concentrator. The pipes all communicate with a closed box built around the revolving screens and the bins. At the top of this box a similar pipe, 2 feet in diameter, is connected with a powerful blower, sucking the dust out of a box into a dust-chamber fixed under the roof of the building. The tailings are dropped near the discharge of the water-wheel and carried away down the cañon by the current.

The first work done by the mill was the concentration of the De Soto dump. It consisted of all the refuse remaining on the dump after assorting the ore by hammer-dressing. It had accumulated since the mine was first discovered. The amount was about 750 tons, assaying, it is reported, on an average about $25 per ton. It required 40 tons to obtain one of concentrated stuff. The three sizes resulting, assayed at the rate of about $900 per ton. The product of the dust-chamber assayed about $120, and the dust from the 100-mesh screen about the same. The latter value is higher than from other ores crushed. The tailings assayed from $3 to $4 per ton.

The next work was done on the Sheba dump of about 450 tons. It was likewise the refuse of hammer-assorting, and assayed on an average about $33 per ton. It required over 23 tons of ore to make one of concentrated stuff. The latter assayed about $800, and the product of the dust-chamber and 100-mesh screen about $90 per ton. The tailings were not assayed.

Since these large quantities were passed through, the water in the creek has diminished and the mill can be worked but a few hours every day. The ore coming out of the Sheba and the De Soto mines has been concentrated regularly since the working of the dumps, 13 to 20 tons making 1 of concentrated material.

There being no assays of every lot crushed and of the concentrations obtained, it is impossible to give correcter and more detailed data which would permit calculations as to the economical results. The superintendent thinks that, according to the proceeds obtained and assays made, the mill must save on an average about 90 per cent. of the contents of the ore.

The mill, when running to its full capacity, can concentrate from 40 to 50 tons in 24 hours. The present mines in Star district cannot furnish enough ore to run the mill all the time. The total ore raised in Star district in 1873 was about 500 tons; ore and tailings concentrated at the Krom Mill, 1,550 tons; yield at Winnemucca, Reno, and San Francisco, $80,060.

The new mining-law has been received with a good deal of favor, and about fourteen patents for mines and mill-sites have been applied for in the districts above mentioned during the year.

Below I give the bullion-product of Humboldt County for 1873, as ascertained from the shipments by Wells, Fargo & Co.'s Express. It should be remarked that in the amount given for Winnemucca there is only included the bullion which comes from that county, and not the amounts passing through from Idaho. At Golconda there is no assaying done, and the values given are therefore estimated. The Rye Patch bullion is all from the Rye Patch Company's mill; that company had, however, a good deal of ore worked at Winnemucca, so that its product is really higher than given in my statement. The exact amount so worked at Winnemucca I am, however, unable to determine.

Bullion-product of Humboldt County, Nevada, for the year 1873.

Unionville:

January	$19,465 42	
February	26,515 23	
March	29,723 35	
April	23,142 50	
May	26,297 06	
June	16,593 81	
July	20,332 87	
August	20,903 09	
September	18,349 34	
October	20,016 48	
November	21,151 85	
December*	9,882 33	
		$252,373 43

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* The Arizona Mill was repairing most of the month.

Mill City, (mostly from Central district)		$7,395 00
Winnemucca		93,935 00
Golconda:		
April	$200 00	
May	400 00	
June	210 00	
July	400 00	
August	600 00	
October	1,100 00	
November	200 00	
December	300 00	
		3,410 00
Rye Patch:		
January	6,712 93	
February	5,234 00	
March	10,144 00	
April	13,251 00	
May	23,813 00	
June	6,511 00	
July	8,328 00	
August	7,939 00	
September	7,723 25	
October	19,831 35	
November	15,400 00	
December	9,650 00	
		134,537 53
Oreana:		
April	2,550 00	
May	2,250 00	
June	2,800 00	
July	1,135 00	
August	1,350 00	
September	800 00	
October	775 00	
November	825 00	
		12,485 00
		504,135 96

The amount and value of ore shipped to San Francisco for treatment is not ascertained. It represents certainly several hundred thousand dollars.

ELKO COUNTY.

The production of this county has fallen off considerably during the year. The gross yield of the ores for the first quarter of 1873 is given by the county assessor as $46,979.43; for the second quarter as $102,534.60, while tailings producing $2,800 have been worked. Of the two smelting districts, Railroad and Spruce Mountain, only the former has continued to furnish bullion.

Spruce Mountain district has lain idle during the whole year, the Ingot Mining Company having failed to make its mines remunerative. Their large deposits of ore, the only ones so far opened by them to any extent, carried ores of too low a grade to pay for smelting for themselves; and the Fourth of July mine, which carries ores of a higher grade, was not opened sufficiently, before the means of the company were exhausted, to furnish as much ore as would have been required to produce, mixed with the other materials, a paying bullion. I understand that the company is trying to raise additional capital, and that now, warned by former experience, it will first develop the richer mines, before going into costly smelting experiments with inadequate ores.

Through the courtesy of Mr. J. E. Clayton I am enabled to supplement my last year's report on Spruce Mountain district with the following description:

Spruce Mountain is an isolated range, some twenty miles long from north to south and four to six miles broad. The central ridge is well covered with pine and fir timber; and the foot-hills on the west are densely covered with pine, juniper, and mountain mahogany, so that, as far as the supply of fuel for reduction-works is concerned, the district is well provided for years to come. The geological formations occurring on this range are: first, rhyolite and other porphyries, which have broken and upheaved the sedimentary strata; secondly, quartzite, occurring in brecciated beds in the foot-hills; and thirdly, strata of limestone and shale of the thickness of nearly a thousand feet. The porphyry has broken through these sedimentary strata and occurs in dikes as well as in the shape of intrusions between and parallel to the strata. The general strike of the limestones and shales is north and south; but in different parts of the district both strike and dip vary greatly. Generally, the strata on the east flank of the range dip with the slope of the hills toward the east. On the west side, the stratified rocks are very much tilted and folded, and occur frequently in detached masses. They dip and strike here in various directions and at different angles; and in most cases the latter are closely related to the position and direction of the porphyry intrusions.

Most of the ore-deposits of the district occur in the lime strata, near the porphyry; and the largest and most important are conformable in strike and dip to the limestone beds. There are a few instances, however, where the ore-seams are found alongside of porphyry dikes, thus forming contact-veins. The ores are mostly decomposed lead-ores, in which the carbonate of lead is predominant; galena is, however, found occasionally, and wulfenite, or molybdate of lead, is met with here and there. Very often there is a large amount of quartzose and earthy gangue mixed with the mineral constituents; but there is nothing present that would render the ores refractory. The value of the ores in silver varies greatly, but the grade of the largest masses opened so far is very low. As a rule the small veins contain the richest ore.

Of the mines, the one most extensively worked so far is the Latham. It is situated on the summit of the mountain-range, in a low sag, north of the high timbered ridge from which the district takes its name. The reduction-works and the town of Sprucemont are one and a half miles southwest of the mine. The mineral deposit here lies between, and its dip and strike are conformable to, the line and shale strata. The strike of the outcrop is nearly east and west, and the dip varies from 10 to 30 degrees north.

Some 200 or 300 yards south of where the principal works are located, a large dike of rhyolitic porphyry cuts obliquely through the mountain. Here the strata have been raised, dipping away from the porphyry on each side. A shaft 108 feet deep has been sunk on the summit. The first 30 feet passed through ore; then followed 18 feet of calcareous shale, when a second bed of ore, 7 feet thick, was encountered. Next followed 30 feet of limestone strata, below which a stratum of ore 3 feet thick was found. A fourth bed of ore, the outcrop of which is seen near the mouth of the tunnel, will very likely be struck in the shaft, if sinking is continued. All these ore-deposits are conformable in strike and dip to the limestones. With the exception of the shaft and the lower tunnel, the principal work has been done on the outcrop of the main ore-deposit. At the surface the ores were much mixed with earthy matter; and it was here almost impossible to separate the mineral-bearing portions from the waste, by hand-sorting; but as depth was attained, sorting became much easier. In the large surface-cut there is a thickness of more than 30 feet of ore in sight, yet the roof or hanging-wall of the mass has not been reached. In the two smaller beds, mentioned as having been cut in the shaft, there appears to be much less gangue mixed with the ore than in the large one.

Near the mouth of the lower tunnel a small ore-deposit, called the Carnaghan lode, was pierced. The ore it contains is considerably richer in both lead and silver than that from the large ore-beds. It is said to assay from 40 to 50 per cent. of lead and 30 to 50 ounces of silver per ton. An incline, which has been sunk on the vein below the tunnel floor to a depth of 20 feet, shows the mineral to be from 1 to 2 feet thick.

The Fourth of July mine is situated one-half mile southeast of the Latham, and on the eastern slope of the high timbered ridge. The ore has not yet been found in place in this locality; but a considerable amount of float-ore, mixed with the *debris* from the mountain-side above, indicates that the deposit is not far off. All the ore found so far is much richer in silver and lead than what has been taken from the other deposits. A tunnel has been driven into the hill in search of the ore deposit in place, for a distance of 230 feet. It runs all the way through detritus and broken ground, scattered through which pieces of ore were found continually. From the tunnel floor two winzes have been sunk, respectively, 15 and 25 feet deep, neither of which has found solid rock.

The Fierro lode is an immense lode of iron-ore running east and west and standing vertically. It is distant about 200 feet from the Fourth of July mine and north of it. It is a contact-vein between the limestone and a porphyry dike. Here and there it contains bunches of good lead-ore. No work of exploration has been done on this vein, although it is quite likely that larger bodies of lead-ore may be found in it.

The Agate and Dubuque locations are situated about three-fourths of a mile southwest of the Starr King Company's furnace, in the eastern foot-hills of Spruce Mountain, and nearly two miles southeast of the Latham mine. They seem to be only small pockets of ore in limestone.

The Columbia lode is situated on the north slope of an east spur of the mountain, about a mile east of the Fourth of July. It is a contact-vein between prophyry on the hanging-wall and limestone on the foot-wall. Its strike is northeast and southwest; the dip being about 70° southeast. The ore is carbonate of lead, mixed with oxide of iron, and containing occasional stains of oxidized copper-ores. Very little work has been done on this vein, though its general appearance, and its similarity to the Grecian Bend vein, the principal location of the Starr King Company, would warrant a more thorough explanation.

Railroad district.—For notes of mining operations in this district, I am indebted again, as in former years, to Mr. J. W. Hussey, superintendent of the Empire City Mining Company, the works of which, at Bullion, are the center of activity in the district. Of the mines belonging to the company, the Last Chance has been most thoroughly developed, having a shaft in the middle of the claim, 210 feet deep, intersected by the Last Chance tunnel at the bottom and by an upper tunnel, 90 feet below the shaft-mouth. The stope worked out above the upper tunnel is 22 feet in length, by 5 to 24 feet in width—this being the whole thickness of the vein. The ore (carbonate of lead and galena, with copper-ores) ranged from 25 to 170 ounces silver per ton, the greater part carrying between 35 and 50 ounces. Between the two tunnels, the ground worked out is 30 feet long, 20 to 45 feet wide, and about 60 feet high. Considerable masses of copper-ores are still standing, which cannot at present be profitably treated. The quality of the mass will be tested from the tunnel below. In this tunnel a winze has been sunk about 70 feet, showing alternately predominant ore and waste rock. At the bottom it has been widened to an area 35 feet wide by 14 feet long, without finding the wall rock. The ore in the bottom is not of high grade, but is favorable in character, assaying, as an average, 45 ounces of silver and 22 per cent of lead, (largely galena,) and carrying considerable amounts of pyrites. The dumps contain about 200 tons of ore, which has not been treated, on account of its contents in copper rendering it unsuitable for the process now employed, except when mixed with iron pyrites and melted so as to form matte.

Another of the company's mining operations, the Hussey tunnel, cuts the location of Lone, True, and Red Jacket, different strata of the same lode, which is said to be fully 60 feet in width. Four strata have been worked. The first, lying on the foot-wall, is irregular as far as worked, namely, 15 feet above the tunnel, and, by shaft, 20 feet below. The ore above the tunnel averaged 50 ounces per ton; below, it is of higher grade. The stratum in bottom of the shaft is from 6 inches to 2 feet in width. The second stratum has been worked 40 feet above the tunnel, and partially 80 feet below. It averaged fully 5 feet wide, and carried 80 ounces silver per ton. Several hundred tons have been taken from it. The ore now in the bottom of the shaft is 1 foot in width. Stratum No. 3, showing ore of the same character as No. 2, has been worked 15 feet above the tunnel and 75 feet below. The air is very bad in the bottom of this shaft—the only place where bad air has yet been found in the mines. Stratum 3 feet in bottom, partly ore and partly gangue. Stratum No. 4, 10 feet from No. 3, has been worked 20 feet above tunnel and 60 feet below. This strata is the widest yet found in the Hussey tunnel, and carries both the low and high grade galenas, varying from 30 to 100 ounces silver per ton. The ore is at least 10 feet in the bottom, one-half of which is galena; length not ascertained. A shaft is to be sunk in the main tunnel to strike this body, through which from 10 to 20 tons can be raised daily. There are various strata of ore in this tunnel from 1 inch to 6 inches in width, still running into the hill. Experience has taught that these are liable at any time to widen.

The Elko tunnel was purchased this year by the company for $1,000. It enters the hill 100 feet below the Hussey, and cuts the same vein at a distance of 137 feet, at a point 160 feet farther west. The vein is here filled with ledge matter, small stones, mixed with bowlders of ore. The ore, 25 tons of which were taken out, resembles the ore of Last Chance.

A contract was let in December to run the Empire City Mining Company tunnel 250 feet into the hill. This tunnel is located at the lowest available point on this side of the mountain. It will cut all the veins about 400 feet from the surface, intersecting the Hussey-tunnel vein about 200 feet and the Last Chance 430 feet from the tunnel-mouth. The cost of running this tunnel by contract is $4 per foot in ledge matter, $6 in porphyry, $15 in hard limestone. The Elko tunnel is contracted at $8 per running foot.

Smelting operations are carried on under numerous disadvantages, chiefly the lack of suitable floating capital and the delays incident to obtaining the proceeds of bullion shipped. Mr. Hussey gives, in a report prepared for submission to the company April 1, 1874, the following summary:

> As my last report stated, the blast used in 1872, for running the furnace, was produced by a Sturtevant blower. The capacity of the furnace with that blower was 16 tons per day. Mr. Hahn, who was at that time employed as smelter, suggested that the blast was not strong enough, and, being convinced of that, I ordered a No. 4 Root blower, which replaced the Sturtevant. By this means the ore was increased to 25 and 28 tons per day, and the amount of charcoal used for smelting decreased from 40 to 30 bushels for the ton of ore.
>
> Mr. C. Weberling, who was in charge of the works while I was in the East, attempted to start the furnace ere my arrival, but owing to a breakage in the machinery, which had to be sent to San Francisco for repairs, did not succeed until my arrival on the ground. We commenced running the furnace on the 26th day of May, and it ran forty-nine days. The products of this run, as well as of the runs made afterward, with the expenses incurred in producing the bullion, will appear in a paper attached hereto. This run demonstrated one fact—that the copper in the ore was detrimental to the easy reduction of the ore; also causing a decided loss in the bullion itself, for the refineries would find much more dross than the amount of copper contained. One thing was gained: that was the impression that a proper supply of pyrites of iron would effectually clear this copper from the lead. A small supply of poor pyrites was obtained from the west side of the mountain, and its use confirmed the impression, though entire separation was not fully attained. The importance of the pyrites being now demonstrated, I visited Cortez and Battle Mountain districts to obtain it. I procured from Cortez an ore formed about equally of pyrites of iron and galena, carrying 60 ounces of silver per ton. This ore proved very satisfactory, and if it could be procured in quantity at a reasonable price, would leave nothing to wish for. The next season will determine whether the supply can be had there or not. The ore from Battle Mountain was pure pyrites of iron, carrying 10 to 15 ounces of silver to the ton, and its use was satisfactory. By the use of this pyrites an increased quantity of copper matte is produced, and the bullion is free from copper. The additional cost of the smelting is the cost of the pyrites. When the galena in the ore is abundant, little or no pyrites is used. We expect to treat, the coming year, ores containing a greater percentage of copper than have yet been treated. Some of the last bullion produced contained copper, but it was owing to the fact that we did not always have pyrites on hand.
>
> Many obstacles were encountered in starting the furnace for the second run. The ores had changed somewhat, and that change was not fully appreciated until smelting commenced; then the furnace got plugged up with an "iron sow." It was blown out, the "sow" cut out, and furnace started; again the same difficulty was encountered.
>
> It was now determined by Mr. Weberling and myself to ascertain if other means could be found to free the furnace without stopping. I had just received the coke ordered from Pennsylvania, and directing the free use of that, with charges of galena, in the course of eight days the furnace was clear, and I apprehend no danger from that source again. The cost of these experiments over and above the ordinary cost of smelting I should estimate at $5,000, and the result of the trial was as follows: The quantity of fuel previously used to each charge of ore was two bushels of charcoal. The ore smelted in twenty-four hours by its use was from 25 to 28 tons. The cost of 12 pounds coke equaled one bushel of coal; by substituting the 12 pounds coke for one bushel of coal, the amount smelted in twenty-four hours was from 30 to 35 tons, making a difference in favor of using one-half coke of fully 20 per cent. in favor of coke. I have reason to believe that a still better result than that will be reached by the use of more coke.

The base bullion produced was sent to Balbach & Son, Newark, N. J.; Selby & Co., San Francisco; the Chicago Smelting Works, and the Montgomery Works, at Bloomfield, N. J. The total net receipts from 41 car-loads, amounting to 419.89 tons, was $78,683.06, from which I infer that the average assay value of the bullion in silver was about $170.

Another enterprise in Railroad district is the Webfoot mine, owned by a San Francisco Company, Mr. A. J. Raulstone, superintendent. The shaft is 100 feet deep, and 129 tons of ore, extracted during the year and smelted by the Empire City Company, yielded 43 tons of base bullion, assaying 165 ounces of silver to the ton. This ore was smelted with extraordinary ease. In the last ten hours of the run, 8 tons of bullion were produced.

Some 300 tons of siliceous copper ore, assaying about 24 per cent. of copper, were shipped during the year from this district. The veins promise well, but need to be more thoroughly developed in depth.

Cornucopia district is a new district, which has come into notice during the year. It is situated 75 to 80 miles north of Carlin, on the Central Pacific Railroad, and about 45 miles west of Cope district. The ledges are reported to occur on the contact between slates and limestone, and to carry exceptionally rich ores. The fact that many of these ores assay over a thousand dollars to the ton in silver, and some gold, has created a considerable local excitement. Only small lots of ore, however, have been tested during the summer with what are claimed as highly satisfactory results. So far, the ores are decomposed milling ores, and very few sulphurets have as yet been found. During the winter the ledges were to be developed, and if they should hold out in size and value, western capital was said to be ready to bring milling facilities into the district.

WHITE PINE COUNTY.

For notes on this county I am indebted to Mr. A. J. Brown, of Hamilton.

White Pine district.—A review of the mining operations in this district for the past year shows a notable falling off in the number of mines worked, and consequently a diminished yield of bullion as compared with former years. Five mines only have produced bullion during the year, viz, the North Aurora, Original Hidden Treasure, Edgar, Caroline, and French. A few tons have been scraped together by "chloriders," but much less than in former years, as there have been no facilities for working custom ore in small lots. There were produced in the district since the 1st of January, 1873, 13,840$\frac{109}{2000}$ tons of ore, which yielded, together with 5,930 tons tailings reworked at the mills, $502,532.

This marked depression in the mining industry can be readily traced, partly to the exhaustion of the large bonanzas found near the surface in the leading mines and the failure to prospect for others in depth, and partly to the passing of several mines into the possession of two large companies. The South Aurora Company has done some further prospecting during the summer with their diamond drill, a system of prospecting losing favor in this district, as it is found to be unreliable. In these limestones it often passes through bodies of decomposed stuff, without bringing either core or pulp to the surface. Most of the ore bodies so far found in Treasure Hill have been much decomposed; hence it was in the very place where a core was required that none was produced by the drill.

The 60-stamp International Mill, destroyed in August, 1872, has been replaced by one of 30 stamps, with all the latest improvements in mill machinery. It has proportionally a greater crushing capacity than the one destroyed, and is otherwise far more efficient. It started on the 1st of December, 1873, with 1,200 tons of ore on hand at the mill, and 800 at the mines. Its daily capacity so far has been 45 tons per day. The Stanford (30 stamps) and the Manhattan (24 stamps) are the only other ore mills that have run during the year. The tailings mill at Shermantown has run constantly for the last four months, producing bullion worth $300 per day.

North Aurora.—Early in the year an entirely new body of ore was found in this mine at a depth of 240 feet from the surface, in hitherto unexplored ground. From this bonanza there have already been extracted 8,000 tons of ore, 6,046 tons of which were worked at the Stanford Mill, giving a gross yield of $298,892.82, or about $49.41 per ton. From all appearances there is ore enough still remaining to keep the company's mill at work for one year at least. This body of ore is situated at about the center of the mine between the Risdale and Lady's chambers and will probably eventually connect them, thus forming a continuous ore-body from the Ward Beecher Consolidated to the south part of the South Aurora mine, a total distance of 2,000 feet north and south. The present working level is 260 feet from the surface, but a drift from the main shaft taps the ore 50 feet deeper. The extent of this body cannot yet be determined; but the indications are good for an extensive ore-chamber at that depth. The space already worked out in this part of the mine is 180 feet in length, 80 feet wide, and 25 feet high. The material as it comes from the mine consists of about one-third waste and two-thirds ore, and is sorted by throwing out the large pieces of lime and spar and sending the remainder to the mill. About seventy men are employed in the mine, and ten at sorting the ore. The wages of miners and sorters are $4 per day; of shovelers, carmen, &c., $3.50.

Edgar.—This mine has been worked by several different parties for the last four seasons, but without profit to the owners. During the past summer, however, a greater depth has been attained, and a marked improvement both in the quantity and the quality of the ore extracted has been the result. A vast amount of ore is yet in sight in this mine, that will give a pulp assay of $45 per ton, but the percentage of silver saved in the mill is so low that the company appears to be discouraged, and has closed the mine indefinitely. Negotiations are pending with the South Aurora Company for the purchase of the property. Should they succeed in getting it, there is no doubt that with the Stanford Mill, and the careful management that has characterized that company's affairs in this district, the property would soon be put upon a paying basis. The ore-body known to exist is 300 feet in length by 90 feet in breadth, and its depth is unknown. In fact the mine is fully the equal if not the superior of the North Aurora, in point of reserves.

Wheeler Tunnel.—This tunnel belongs to the O. H. Treasure Company, and was run with a view of prospecting that mine in depth. During the summer drifts have been run north and south on ledge matter for about 150 feet. A large body of brecciated stuff, mixed quartz, spar, and lime, has been found; but the grade is too low for any practical purpose. The depth below the highest point of Treasure Hill is claimed to be 600 feet. No survey has, however, been made, and I am inclined to think that the depth is overstated. Prospecting is still going on with encouraging indications. A small quantity of ore has been taken from the Original Hidden Treasure during the season, but the mine may be considered completely exhausted.

Silver Wave.—The main shaft on this mine has been sunk to a depth of 300 feet from the surface, and a drift extended 50 feet southeast, without finding anything of value.

Sheboygan and Copper Glance.—No work has been done on these mines during the year. A United States patent has been applied for, and work will probably be resumed next spring.

Mammoth.—A prospecting tunnel is being run to strike this mine 300 feet under the croppings. Its present length is 150 feet, and some favorable indications have been found. About one-half of the tunnel is in quartz, assaying $25 to $30 per ton.

The Mobile Consolidated is a base-metal mine, situated near the eastern base of White Pine Mountain. The vein is about 3 feet thick and courses east and west, with a southerly dip of 76°. This mine has been opened by a tunnel along the course of the ledge 300 feet in length; also by one shaft 60 feet deep. The principal ore found is cerussite, varying in color from pure white to dark gray. It yields from 45 to 60 per cent. of lead, and from $15 to $400 in silver, with a trace of gold.

Caroline.—This mine still continues to be worked profitably. The vein has lately increased from the usual thickness of about 3 inches to nearly 1 foot. The ore is a smelting ore, and varies in value from $150 per ton for second to $800 for first class. It is hauled to Eureka and sold to the Richmond Company.

French.—This mine employs two men on an average, and pays gross about $12,000 annually. It has been one of the most profitable in a small way, in the district. The vein lies nearly horizontal and is very irregular, varying from a mere seam to 2 feet in thickness. It has heretofore been found in a thin bed of white limestone, overlying stratified calcareous schist. It has been traced to the line of contact between the two formations, which it appears to follow, dipping with the schist to the southwest. Lately this mine has developed a fine body of ore 4 feet thick, which corresponds with the schists in dip and strike. The ore is the richest ever found in the mine, and is estimated to be worth $1,000 per ton.

Several base-metal mines have been worked in a small way for parties in New York, but I am not apprised as to their intentions further than that rumor has it that they will erect furnaces during the next summer.

Parties have been prospecting for coal for the past two years in the low range of mountains known as Pancake Mountains. It is situated fourteen miles from Hamilton, near the road to Eureka. The enterprise has at present the appearance of being quite successful, at least it is reported that coal of fair quality has been found in a vein 4 feet thick. A depth of 200 feet on the vein has been reached by an inclined shaft following its dip. A considerable quantity of water has been encountered, which will prevent further prospecting without the aid of machinery. According to some experiments made on a small scale, the coal cokes. Should further developments prove the formation as extensive as anticipated, the discovery will prove of incalculable value to the smelting interests of Eureka and other base-metal districts in Eastern Nevada.

County assessor's report of ore worked in White Pine County for the quarter ending March 31, 1873.

Name of mine.	Tons.	Pounds.	Dollars.	Remarks.
Columbus	11	240	881	Robinson district.
Hays	5	....	825	
Iceberg, South	4	680	344	
North Aurora	604	1,000	25,062	
Tailings	5,000	....	5,000	
Piermont	420	1,500	5,947	Piermont district.
Silver Plate	6	220	367	
Total tons of ore	1,051	1,640	33,425	Average value of ore per ton for first quarter, $31.80.
Tailings	5,000	....	5,000	

County assessor's report of ore worked in White Pine County for the quarter ending June 30, 1873.

Name of mine.	Tons.	Pounds.	Dollars.	Remarks.
Caroline	10	....	2,100	Worked at Richmond Furnace, Eureka.
Columbus	7	1,500	520	
North Aurora	2,952	1,600	148,690	
Hercules Gate	1	....	129	Hercules Gate district.
Industry	....	500	175	
Rattler's Joy	1	300	1,218	Ruby Hill, Schell Creek district.
Silver Plate	11	....	741	
French	13	500	3,585	
Ward Beecher Consolidated	1,606	....	20,722	
Total ore crushed	4,604	819	177,881	Average value of ore per ton for the quarter, $38.20.
Trinity tailings	300	....	951	
	....	....	178,832	

County assessor's report of ore worked in White Pine County for the quarter ending September 30, 1873.

Name of mine.	Tons.	Pounds.	Dollars.	Remarks.
Barras Marcus	1	1,000	242	By chloriders.
Blair & Banner	6	1,000	400	
Bradshaw	3	180	157	
Columbus	2	....	178	
North Aurora	2,606	1,000	106,854	
Exchequer	119	....	16,034	Cherry Creek district.
Genesee	6	400	300	
Noonday	4	400	239	
Pocotillo	49	1,500	1,609	
Rescue Duquete	5	800	530	Cherry Creek.
Sanchez	6	600	542	Do.
Shepardson	2	1,700	228	
Silver Plate	15	....	474	
Silver Star	34	200	1,482	
Silver Wedge	1	850	132	
Spaulding	2	130	444	
South Aurora	1	700	145	
Do	10	....	665	
Ward Beecher Consolidated	1,906	....	32,756	
Total	4,784	1,250	162,811	Average yield for the quarter, $34.47 per ton.
Tailings	600	....	2,926	
	....	....	165,737	

County assessor's report of ore worked in White Pine County for the quarter ending December 31, 1873.

Name of mine.	Tons.	Pounds.	Dollars.	Remarks.
Battery	60	1,000	1,530	
Caroline	14	400	2,470	White Pine district.
Chance	12	....	900	Cherry Creek district.
Eberhardt and Aurora	1,123	....	36,913	White Pine district.
Exchequer	55	1,000	6,342	Cherry Creek.
Flagstaff	3	1,000	258	
Hays	100	....	1,874	Robinson district.
Do.	40	....	501	Do.
Maryland	92	....	16,202	Pinto district.
McMahon	80	....	1,200	Schell Creek district.
Mineral City	35	....	1,000	Robinson district.
Nutmeg	10	....	500	Schell Creek.
O. H. Treasure	263	....	5,884	White Pine district.
Silver Star	30	....	1,440	
Victoria	....	1,600	135	Cherry Creek.
Chihuahua	300	....	5,984	Base, White Pine district.
Dictator	6	800	472	
Lookout	2	....	350	Ruby Hill, Schell Creek district.
Scott	5	250	286	Do.
Silver Stone	6	1,200	396	
French	41	800	5,998	White Pine district.
Ward Beecher Consolidated	1,044	....	19,645	Do.
Ward Ellis	20	250	642	Robinson district.
Watson Tailings	20	....	234	Do.
Wande	4	100	452	
Total	3,369	400	118,608	Average value of ore for last quarter, $35.17 per ton.
Tailings	30	....	930	
	....	....	119,538	

Robinson district.—Mining has not been as actively carried on in this district as was anticipated in the commencement of the year; nor has it been attended with the amount of success which the size of the lodes or deposits and the grade of the ore would warrant us in expecting. Yet, upon the whole, there has been considerable progress. The idea of reducing the ores by smelting has, after numerous partial failures, been about abandoned for the present. An attempt has been made by the Watson Company to work them in the ordinary Washoe stamp-mill, without chlorination, but with very indifferent success so far. It is lately claimed that some entirely new process has been introduced, which is completely successful.* Probably another year will witness at least a partial return to smelting, as by far the largest portion of the ore so far found contains too large a percentage of lead, iron, and other minerals to be successfully reduced by any other method.

Altman.—Work has been actively carried on in this mine during the past year, and a body of vein-matter, 800 feet in length by 250 in breadth, and 300 feet in depth, has been developed. The main tunnel is 800 feet in length, and taps the ore 250 feet from the surface. Several side-drifts, aggregating some 300 feet in length, connect it with the bottom of the main shafts. There are eleven shafts in all, some of which are mere prospect holes of from 30 to 60 feet in depth. But three or four of them reach a depth of from 100 to 180 feet from the surface. There are about 2,500 tons of ore on the dump, said to average in the neighborhod of $45 per ton.

The Hays mine is opened to a depth of 300 feet from the surface. The prospect is not encouraging. The ore-bodies so far found are mere pockets, and the ore is of low grade and refractory. The Watson Mill has a contract to crush five hundred tons of ore. The first effort at working the ore was a complete failure, but lately considerable bullion has been forwarded to San Francisco on the mine's account, and a complete success is claimed.

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* The new process consists of an infusion of the bark of the mountain mahogany, freely used in the amalgamating-pans. One would think the time for such experiments should at last have passed away.—R. W. R.

Watson Company.—This company was organized in San Francisco in May last for the purpose of working the extension of the Hays and the Katie mines. They have also built a 10-stamp mill near Mineral City, partly for the purpose of reducing their own ore and partly for custom-work.

The Katie mine is opened by an incline shaft, sunk about the center of the claim, to a depth of 100 feet from the surface, at which point drifts are started both ways along the course of the lode. The ledge is about 10 feet in thickness, but the ore is of very low grade, and will not average over $25 or $30 per ton. As is usual in this district, the ore is characterized by a predominance of iron oxide.

Ward Ellis.—This is another new incorporation. A few tons of the ore reduced at the Watson Mill yielded at the rate of $75 per ton.

The Lamb mine has been opened to a depth of 80 feet by a vertical shaft. A small quantity of the ore worked at the Watson Mill yielded $60 per ton.

The Miami (copper) has a shaft near the center of the claim, 70 feet deep. The vein at that depth has widened to about 4 feet. The red oxide and native copper found near the surface have been gradually replaced by black oxide in depth. At the present depth a considerable body of water has been encountered, sufficient to prevent further prospecting without the aid of machinery. The water appears to contain sulphate of copper in solution, as iron left in it is quickly coated with copper, and one week was quite sufficient time to convert the hoops of the hoisting-tub (left accidentally in the shaft) wholly into metallic copper.

The Burnside (copper) is situated near the last named, and has been opened by an incline, 80 feet deep. The vein is about 3½ feet thick, courses nearly east and west, and dips south. The ore is mostly malachite, with occasional specimens of black and red oxide. (Black oxide is a mixture of oxide of copper with sulphuret.)

Troy district.—This district is situated in the White Pine range of mountains, about eighty miles south of Hamilton. It was discovered and organized in October, 1868. In the following summer all the mining property in the district was purchased by a company in Yorkshire, England, which has prosecuted work on the property continuously ever since, but unfortunately with only indifferent success. A fine 20-stamp dry-crushing mill, with Stetefeldt furnace attached, was erected near the mines during the summer of 1870. It has, however, been idle most of the time since its erection. Several attempts at working the ore have resulted unfavorably. The quantity of silver in the ore was not sufficient to pay even the expense of milling. The lodes are encased in a dark, argillaceous shale, and conform to the stratification both in dip and strike. The two principal veins so far exploited are the Troy and the Gray Eagle. These have been fully explored to a depth of 300 feet from the surface, and show well-defined, strong veins, varying in thickness from 2 to 5 feet. The ore consists almost wholly of zinc blende. Hand-specimens contain 50 per cent. of zinc, with a small percentage of copper and iron pyrites. It is claimed that as depth is attained, the percentage of silver has increased, so that there is some hope of the property becoming remunerative eventually.

Cherry Creek district.—This district was discovered and organized in

September, 1872. It is situated on the eastern slope of the Egan Mountains, about five miles north of Egan Cañon. The formation has been upheaved by the intrusion of granite in Steptoe Valley, on the east side of the range. Overlying the granite are two belts of quartzite, with a narrow intervening belt of micaceous slate. The upper quartzite contains the lowermost or exchequer mineral belt. The ore in this belt is found in segregated masses, without any indication of a ledge form, such as a hanging or foot wall. West of and overlying the upper quartzite is a belt of limestone, about 2,000 feet in thickness. The second mineral belt lies along the upper portion of this limestone belt, or between it and the overlying shale. West of the last-mentioned shale is a thick belt of limestone. The mineral belts, so far as traced, extend along the range to the north about six or seven miles. The ore consists of various compounds of silver, gold, copper, antimony, and lead; and, except near the surface, where oxidation has taken place, will prove too refractory for the ordinary Washoe process.

The district promises well for the future, the ore-deposits being large and fairly defined.

Exchequer.—This mine is situated in the quartzite, and appears to be a segregated mass, with nothing characteristic of a vein about it. The ore so far found averaged by assay about $250 per ton, about 50 per cent. of which was saved by mill-process. The mine was sold in September to A. H. Hagadorn and others, who erected a 5-stamp mill to reduce the ore. The company is known as the Rye Patch Company. It is said that the mine has yielded bullion enough to repay the first cost. It is now worked out, and the mill is reworking the tailings. The mine is being energetically prospected, and there is a fair chance that other bodies of ore may be found.

Victoria.—This mine was one of the first located. It is situated about four and one-half miles north of Cherry Creek, and is considered one of the best in the district. Its strike is north and south, dip west. The vein matter is 20 feet thick, with an ore-streak of about 4 feet, 2 feet of which is quite rich. The inclosing rocks are said to be porphyry. The developments consist of two shafts, one about 60 feet deep, the other 25 feet, also a tunnel, run along the hanging-wall of the lode for 100 feet. Assays range from $50 to $6,000 per ton. The ore contains antimony, copper, and lead, associated with the silver.

Geneva.—This ledge is about 15 feet in thickness, and crops boldly the whole length of the claim. It lies between the quartzite and limestone, the latter being the hanging-wall. The lode is opened by a shaft 30 feet deep. The ore contains a large percentage of gold, and assays range from $50 to $2,000 per ton for selected specimens. Selected ore from most of the mines in this district will probably work from $100 to $500 per ton, but the great mass of the ore will not exceed $30 per ton. The above lodes belong to the low belt. There are a number of others of fair promise, but so little developed that no estimate of their value can be formed.

The Pine-Nut mine is situated in the upper belt, about three and a half miles west of the town of Cherry Creek, and near the summit of the range. The hanging-wall is limestone, foot-wall quartzite. The course of the deposit is northeast and southwest, or diagonally across the general course of the mineral belts. Developments consist of an open cut and shaft about 30 feet deep. The vein is not well defined, either near the surface or at the bottom of the shaft. Much of the ore is rich, assays ranging from $60 to $5,000 per ton. There are about 100 tons on the dump.

The Tea-Cup runs north and south and dips to the west. The foot-wall is shale, the hanging-wall limestone. The developments consist of an inclined shaft, following the dip of the lode for 120 feet in depth, and of short drifts each way on the lode from the bottom of the incline. The vein is about 5 feet thick, and contains a 15-inch pay-streak. There are 100 tons of ore on the dump, worth $75 per ton.

Baltic.—This mine is situated in Silver Cañon, three miles north of Cherry Creek. The course of the deposit is north and south, the dip west. The thickness varies from 20 to 30 feet; the pay streak is about 5 feet wide. The developments consist of two shafts, one near the center of the claim, 35 feet deep, and one at the north end, 60 feet deep. About 150 tons of ore now on the dumps are worth about $150 per ton.

Chance.—This mine with a number of others not so well developed is situated between the two last named. There is about 10 feet of vein-matter between walls, with a 3-foot pay streak. The developments consist of one vertical shaft, 60 feet deep, and one incline 25 feet deep. About 70 tons of ore have been extracted from the incline that will pay about $150 per ton. The ore in this mine differs from that of any other in the district. It contains, in addition to the usual minerals of the district, considerable metallic silver. Picked specimens are literally covered with the pure metal.

Schell Creek district.—Very little work has been done in this district during the past year. The prejudice prevailing against limestone formations has seriously retarded progress by preventing the introduction of the capital necessary for the prosecution of mining enterprises. The character of the ore has also interfered with the prosperity of the district, the percentage of antimony and copper in conjunction with sulphur having seriously hindered amalgamation.

The McMahon mine is the only one in the district that has made even a show of continuous work. A shaft has been sunk on the lode to a depth of 200 feet from the surface, and drifts have been run 25 feet each way from the bottom. The ledge at the bottom of the shaft is 4 feet thick. The ore is of good grade, but refractory. A 5-stamp mill has been erected for the purpose of reducing the ore; but, so far as I can learn, has not yet started.

On Queen Spring Hill the Nutmeg has been worked with very favorable prospects. A shaft has been sunk 30 feet in good ore. The mine, owing to legal trouble, is now lying idle.

The Enterprise strikes north and south and dips to the west. The vein is about 10 feet thick and is opened by three open cuts about 50 feet apart, showing a continuous vein for the entire distance. Some 30 tons of good ore, worth $50 per ton, are on the dumps.

The May Queen runs east and west and dips to the south. The developments consist of a tunnel, 100 feet in length, striking the ledge 150 feet from the surface, where good milling ore, 10 feet thick, is exposed.

The Nutmeg Grater is opened by a surface cut 10 feet in depth. The ledge is 10 feet thick. The ore assays from $60 to $1,500 per ton.

Ruby Hill.—The mines in this part of the district have been involved in a lawsuit almost ever since their discovery, and have consequently laid idle. A 5-stamp mill, erected in the vicinity two years ago, has never dropped a stamp. "Chloriders" have been at work during the past summer, and have shipped a few tons of ore to Eureka, which yielded about $1,200 per ton.

Silver Creek district is situated six miles south of Ruby Hill, on the eastern slope of the same range. A dozen or more mines have been located, and very large bodies of cerussite have been found. The silver assays range from $30 to $100 per ton.

NYE COUNTY.

Philadelphia district.—This district has been looked upon with a great deal of interest by the mining operators of the Pacific coast during the past year. Since the three principal mining properties of the district have been bought by San Francisco companies, vigorous prospecting has been continually going on, and as in all these mines extremely rich ore-bodies had formerly been found, it was natural that a speculative mining community, such as that of the Pacific coast, should be in an almost permanent fever of expectation. In the fall of 1873 these expectations seemed to have been fulfilled all at once, so far, at least, as the Belmont mine is concerned. Rumors of a very rich strike reached San Francisco, and the stock of the Belmont company rose at once from the vicinity of $5 to $32 per share. But the next few weeks were sufficient to show that the first report had been much exaggerated, and the stock dropped more precipitately than it had risen. A correspondent describes the position of the alleged strike substantially as follows: The main incline of the mine is 240 feet deep, down to the water-level; a drift is here run along the ledge northward, for a distance of 517 feet, where a winze is sunk on the ledge for 80 feet. As it was known that in the spring of last year a rich body of ore 270 feet long and 7 feet wide had been found in the same level, 550 feet north of the main incline, it was universally expected that the new strike in the winze would prove to be the continuation in depth of this chimney, and that, therefore, a large amount of ore was again available for extraction. The winze spoken of follows the dip of the ledge, which is about 70° east, for about 45 feet, when it changes suddenly to almost vertical. A cross-cut in the bottom of the winze revealed a thickness of 7 feet of high-grade ore. From the cross-cut drifts were run north and south for a distance of 175 feet, which contained good ore for the entire distance. This ore was, at the time of the strike, thought to mill at least $300 per ton; but the average contents were afterward found much lower. From the floor of this lower level another winze, 24 feet deep, was sunk, and here, too, the ore was found. There was also a main level driven 160 feet below the water-level, from the incline northward toward the ore-body. This level was intended to be the working level, after it should have reached the ore. Before the completion of this level practically no ore could be extracted from the new body, since there was no access to the main incline except by raising the ore first up the winze and then transporting it south along the water-level for over 500 feet. As the ore would thus have to be rehandled several times, mining would, in this way, have become too expensive. The new strike is located in what is known as the Moore and Martin ground. At the end of the year the lowest level was 125 feet long, and had reached ore. Shortly after 20 tons of assorted ore, which worked, by mill process, $125 to $150 per ton, were raised daily. The drift was meanwhile being driven on with the intention of reaching the large ore-body struck in the winze spoken of.

The company intends to shortly commence the sinking of a vertical shaft east of the present works, which will strike the ledge at a depth of nearly 400 feet, and from which the mine can, in the future, be prospected and worked at a considerably smaller expense than at present. At the end of the year there were forty men working in the mine.

At the Highbridge mine there were, at the same time, ten men at work, who, at a depth of 280 feet, were running a drift to strike the ledge. This drift was, at that time, within 90 feet of the vein.

The El Dorado South has also been doing principally prospecting work. At the end of December 12 tons of ore were raised daily, which, assorted for milling, yielded between $200 and $300 per ton. A drift was being run south at the 490-foot level, and from the 400-foot level a winze was being sunk to connect with the level below. This winze was in high-grade ore. Some stoping was being done in the 490-foot level on a 6-foot ledge of rich sulphuretted ore. From the floor of the 490-foot level another winze was being sunk to make connection with the 560-foot level. In the latter level the ledge is 5 feet thick in the north drift and 2 feet in the southern one. Both are in good ore. In the ore-houses of the mine there were stored at the end of the year about 1,000 tons of rich ore awaiting the starting of the company's mill.

The Monitor Belmont's new vertical shaft is down about 230 feet. This shaft is 9 by 5 feet in the clear, divided into two compartments, and timbered with 3-inch plank. There is a safety cage in use, and the water is hoisted by means of 70-gallon tubs. Friction-gear is used for hoisting. At a depth of 200 feet a drift is being run from the shaft, and is expected to cut the vein at a distance of 184 feet. About 80 feet are now completed. This drift will intersect the vein 300 feet below the old works in No. 2 tunnel. In all the intervening ground no stoping has ever been done; and, as it is known that the ledge above No. 2 tunnel for 1,000 feet in length contained the longest and richest ore-body ever found in Belmont, great expectations are entertained for the future, especially as the winzes so far sunk below No. 2 tunnel are in good ore.

On the El Dorado North, which lies between the El Dorado South and the Monitor, a shaft has been sunk to a depth of 30 feet. It is expected that this shaft will cut the vein at a depth of 146 feet. Large hoisting-works are to be erected immediately. Prospecting work is also being done on the North Belmont, the Quintaro, and several others.

The Monitor Belmont Mill is the joint property of the Monitor Belmont and the Belmont Companies. It contains a Stetefeldt roasting-furnace, ten stamps of 1,000 and ten of 750 pounds each, seven Stevenson pans, and six settlers. The motive-power is furnished by two forty horse-power engines, which are supplied with steam by two 54-inch boilers. The mill was running a great part of the year on ore from the Belmont Company's mines.

The El Dorado Mill contains also twenty stamps and a Stetefeldt furnace. Six Stevenson pans and three very large settlers are attached.

The Combination Company's 40-stamp mill has been idle for a long time.

The product of Philadelphia district for 1873 was as follows:

Belmont Mining Company:

April	$13,995 19	
May	32,272 83	
July	16,464 94	
August	8,449 94	
September	9,468 00	
December	14,014 09	
June	21,556 11	
October	9,177 73	
December	16,852 31	
		$142,251 14

Monitor Belmont Company:

January	56,979 00	
February	22,065 00	

March	$43, 865 00	
April	10, 575 00	
May	2, 683 00	
June	12, 688 00	
July	6, 293 00	
August	26, 697 00	
September	16, 664 00	
October	10, 647 00	
November	1, 007 00	
December, (no returns.)		
		$210, 163 00
Net bullion-product of El Dorado South Consolidated Mining Company for 1873*		260, 108 72
Total		612, 522 86

Morey district.—The Morey Mining Company has continued the extraction of ore from its mines during the year, most of which has been stored, awaiting the completion of the mill which was commenced some time ago. This mill has ten stamps and is now ready to do work. About twenty men were employed in the mines at the end of the year.

Twin River district.—The Twin River Mining Company has done prospecting work, mostly in the Murphy mine. Some good ore has been found and extracted, which has been piled on the dumps to await the starting of the mill in the spring.

In *Troy district*, the principal mines of which are owned by an English company, no new developments of any consequence have been made, and the fine 20-stamp mill with Stetefeldt furnace has been idle.

In *Tybo district*, twelve miles south of Hot Creek, on the same range, occur both milling and smelting ores, which it is thought contain at least $60 per ton without sorting. No bullion has been produced in the district as yet, but it is expected that active work will be commenced in the spring by Mr. J. B. McGee, formerly superintendent of the Richmond Consolidated Company at Eureka. This gentleman has bonded the following mines: From Gally & Gillett, 1,200 feet of the Two G, 400 feet of the Hunkidori, and 500 feet of the Lafayette; from the other owners, the remaining 700 feet of the Hunkidori; and from Page & Co., 640 feet in the Casket.

The total product of the mines of Nye County during 1873 is reported as 11,881½ tons of ore, yielding in gross $748,557.89.

ESMERALDA COUNTY.

There is nothing of importance to report from this county. Explorations have been continued, particularly in Gold Mountain district, where, among others, the Manhattan Company, of Reese River district, has spent some $10,000 (according to the official accounts of the company,)

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[*] The statement sent to me, in regard to the yield of the mines of this company, says:

Produced from May 20, 1871, to December 31, 1873	$303, 968 72
According to my previous report the product of the only mine of the company then producing was in the first quarter of 1872, (during which time almost the only shipments in that year were made)	43, 860 00
I have included possible small shipments in the latter part of 1872 in this year's product, giving it as	260, 108 72

but with what result I am unable to say. The absence of any positive news may be taken as an indication that the developments made had been thus far inconclusive.

LINCOLN COUNTY.

From Pahranagat and other outlying districts there is nothing to report. The mining industry of this county centers at Pioche.

Ely district.—The production of this district has very materially decreased during the year. This is owing principally to a falling off in the value of the ores of the two largest companies, but also, in part, to the extensive litigation going on in the summer between the Raymond and Ely and the Hermes, and the Raymond and Ely and Kentuck, during which time the best ore-ground of the Raymond and Ely was closed up. The facts in regard to the former litigation are presented elsewhere in this report. Ely district produced in 1872, $5,321,007; in 1873 the whole product has been only $3,735,596.78. Of this amount $3,467,561.47 was fine bullion, shipped by Wells, Fargo & Co., and $268,035.31 was the Meadow Valley Company's base bullion, which was shipped to San Francisco by slow freight. The product of the district is divided among the different companies as follows:

Raymond and Ely, H. H. Day, superintendent	$2,365,352 28
Meadow Valley, D. M. Tyrrell, general superintendent	738,645 00
Pioche, T. R. Butler, superintendent *pro tem*	72,691 44
Washington and Creole, Martin Tarpey, superintendent,	66,320 30
American Flag, John R. James, superintendent	84,937 26
Amador Tunnel, D. E. Mitchell, superintendent	48,560 50
Alps, L. W. Greenwell, superintendent	28,177 46
Chief of the Hill, J. W. Wright, superintendent	36,814 49
Portland, John Blair, superintendent, (about)	3,000 00
Bowery, John Blair, superintendent, (about)	4,000 00
Proceeds of ore extracted on shares from Meadow Valley mine	28,133,27
Bullion extracted from custom ore by Meadow Valley Mining Company's mill, not included in above amount,	9,337 66
Amount of bullion produced from ore from the Newark, Pioche, Phœnix, Hermes, Silver Peak, Huhn and Hunt, Vermillion, Caroline, and Charter Oak, and from tailings worked by the Magnet Mill	249,627 12
	3,735,596 78

According to the report of the Meadow Valley Company, published August 16, 1873, the mine produced during the fiscal year 9,318 tons and 358 pounds of ore. The No. 3 shaft had then attained a depth of 931 feet; No. 5 was 780 feet, and No. 7 was 1,022 feet deep. At the end of the year 1873 the last-named shaft had reached the depth of over 1,100 feet. A very beautiful deposit of ore containing from 4,000 to 4,500 tons was found in the mine during the summer. This mass consisted almost entirely of crystals of carbonate of lead, which assayed about $300 per ton in silver. About 75 per cent. of the contents could be extracted from this ore by the Washoe process, the bullion being .750 fine. At the end of the year the greater proportion of the ore raised was still carbonate of lead. Some small deposits of pure galena had been found, but not enough to raise any apprehensions of increased difficulties in milling. Prospecting is still going on energetically, and the prospects in depth are, so far, not very flattering. The same is the case in the other deep mines of the district, but the coincidence is not to be regarded as indicative of a general law. The following statements are taken from the secretary's report of the Meadow Valley Company, for the fiscal year ending July 31, 1873:

DISBURSEMENTS.		RECEIPTS.	
Balance liquidated.	$81,690 92	Balances liquidated.	$211,273 06
Law expenses and purchase	8,932 39	Bullion yield	933,422 56
Construction account	37,734 14	Sales	8,133 09
Mining costs	360,269 59	Custom milling	21,796 89
Milling costs	342,455 58	Balances unliquidated	62,966 96
Miscellaneous	88,286 26		
Dividends	240,000 00		
Balances on hand ..	43,046 18		
Bullion in transit ...	35,427 50		
	1,237,842 56		1,237,842 56

Statement of the gross proceeds of bullion from the mines of the Meadow Valley Mining Company, and cost of production and reduction of the ores yielding the bullion, for the fiscal year ending July 31, 1873.

DEBTOR.		
To mining department, viz:		
Explorations and dead work	$123,416 97	
Labor in extracting ore	124,051 18	
Mining supplies	91,171 94	
Freight from San Francisco on supplies	1,625 74	
Contingent mine-expenses	8,107 10	
Salaries	11,896 66	
Total expenditures in mining department	360,269 59	
Deduct amount of inventory of supplies on hand at date	13,913 91	
		$346,355 68
To milling department, viz:		
Ore-transportation from mine to mill, (10 miles)	44,146 49	
Chemicals, quicksilver, and other supplies	207,664 73	
Freight from San Francisco on supplies	15,654 60	
Labor in reduction of ores	67,886 26	
Contingent milling-expenses	1,027 00	
Assay-office expenses	6,076 50	
Total expenditures in milling department	342,455 58	
Deduct amount of inventory to supplies on hand at date	55,765 82	
		286,689 76
To miscellaneous accounts, viz:		
Freight on base bullion to San Francisco	$6,854 97	
Discount on bullion-yield for current year	39,382 06	
State of Nevada taxes on bullion	14,662 32	
States of Nevada and California property-taxes	4,299 50	
Exchange	534 67	
Insurance premiums on mill-property	2,739 00	
Telegrams	4,269 30	
San Francisco incidentals, salaries, and trustees' fees	12,226 98	
		84,968 80
Total expenses		718,014 24
To net profits for the year		248,970 19
		966,984 43

CREDITOR.		
Bullion:		
By proceeds of company's reduction-works at Lyonsville, as per tabular statements of general superintendent and office records, for the fiscal year ending this date		$933,422 56
Miscellaneous returns:		
By rents of boarding-house for workmen	$250 00	
By sales of materials:		
Mine-supplies	7,689 34	
Mill-supplies	443 75	
By foundery:		
Net sales of castings	3,381 89	
By custom milling:		
Receipts from ore-reduction	21,796 89	
		33,561 87
		966,984 43

The total bullion-product of the Meadow Valley Company from 1869 to the 31st of July, 1873, has been $4,233,296.58. The total net profits during the same time were $1,772,651.19, the total assessments $210,000, and the total dividends $1,260,000.

During the calendar year 1873, the Meadow Valley Company produced

Fine bullion	$470,609 69
Base bullion	268,035 31
Total	738,645 00

Besides the above amount the Meadow Valley Mining Company's Mill produced $38,821.97 from customs ores.

From the very full reports of the president, superintendent, and secretary of the Raymond and Ely Company for the year ending December 31, 1873, I insert the following:

> A short time after the last annual meeting of the stockholders of the Raymond and Ely Mining Company, a diminution became apparent in the quality and quantity of the ore, and, of consequence, in the production of bullion. This condition of affairs has extended throughout the year. We have been, for some time past, and are still engaged in developing and exploring our mines, with every reasonable hope of soon discovering new deposits, corresponding in character with the rich ores extracted in former years. During the year 1872, dividends were paid with great regularity. Anxious not to depart, if possible, from long custom, the trustees paid a dividend in January last, relying for much of the amount on the production of bullion during that month. To this extent, they anticipated the profits of the mine. Had it not been for unusual circumstances, against which no human foresight could provide, they would not have been disappointed. The epizootic unfitted all the horses and mules in Eastern Nevada for work, and oxen had to be substituted in their place. The roads became almost impassable, thereby largely increasing the cost of transporting ores from the mine to the mills. In fact, this increase amounted to nearly 50 per cent. Even with this greatly-increased price paid for hauling by slow teams, it was found impossible to keep the batteries of more than one of our mills running regularly, thus losing for weeks the production of one-half of our milling capacity. The company has taken the precautions against the recurrence of such embarrassments by making large advances for freight to the Nevada Central Railroad, extending some fifteen miles from the mine to the mills. Had the production of ores from the mines continued as large as the developments apparently warranted, one year, the return in the shape of freights earned by the railroad would have been greatly augmented. The railroad is bound to transport our ores for one-half the amount charged by teams. When the mine becomes more productive, the benefits arising from the transportation by the railroad will be more fully realized, besides relieving the company from loss and embarrassment growing out of the stoppage of their mills, in consequence of the bad condition of the roads.
>
> The receipts of bullion during the past year have decreased considerably, when compared with the product of previous years, while our expenditures have been unavoidably increased. A material portion of this increased expense has been incurred in the effort to protect the company's property from parties who were struggling to dispossess the company of a large part of their valuable mining-ground. During the past year the company has expended a large amount in defending its title, thereby diverting the revenues of the mine from the stockholders. Besides the anxiety as to the result of this continuous litigation, it has necessarily greatly embarrassed the management of the company's affairs. When the suit first assumed a formidable aspect, a proposition to compromise was made by the opponents of the company, but it was rejected as exorbitant. The case went to trial, and the verdict of the jury was adverse. Subsequently a settlement was effected upon far more reasonable terms, amounting to little more than one-half of the sum at first demanded. Involved in this suit was the title to 1,200 feet of the Magnet Mining Company's property, adjoining us on the west. That company has agreed to pay one-third of the amount expended by the Raymond and Ely in effecting a settlement. To secure this, that company has conveyed its 1,200 feet of mining-ground to the Raymond and Ely Mining Company. In a recent trial before the court, the title of the latter company to its mining property was fully sustained and clearly vindicated. From this time forward there is every reason to believe that no serious question can arise affecting the title.
>
> Heavy and complete hoisting-works have been erected at the shaft, with ample power to explore the mine to a depth of 2,500 feet. Mining operations during the year have been confined to the Panaca mine. Nothing has been done on the Burke mine and the

Creole mine, belonging to the company. No change in these mines has occurred since the following in the last annual report of the superintendent:

"In the Burke mine we have sunk the main shaft to a depth of 600 feet on the incline. Large quantities of ore of second quality are known to exist in this mine.

"In the Creole mine we have sunk the main shaft to a depth of 641 feet and have run several drifts. But little stoping has been done in this mine, although large quantities of ore of a very fair quality have been developed."

Amount of ore extracted	
Amount ore sent to mills	18,825 1710/2000 tons.
Amount ore reduced at company's mills	27,024 720/2000 tons.
Amount ore reduced at custom mills	24,546 1700/2000 tons.
Average assay value of ore worked at the company's mills, per ton	3,052 1620/2000 tons.
Average percentage obtained	$90 32
Average assay value of ore worked at custom mills, per ton	82¼
Average percentage obtained	$57 68
Bullion produced from ore	76 4/10
Amount tailings work	$1,959,023 53
Average assay value per ton	9,901 1400/2000 tons.
Percentage obtained	$76 44
Amount of bullion produced from tailings	53 7/10
Total amount of bullion from all sources	$406,328 75
	$2,365,352 28

Cost of mining per ton:

Extracting		
Prospecting and dead work	$13 67	
Improvements and repairs	12 19	
Sundries	4 94	
	1 04	
Cost of reduction per ton company's mill		$31 83
Cost of transportation per ton by mule-team		10 84
Cost of transportation per ton by railroad		6 69
Amount of ore at mills		3 09
Amount of tailings at mills		180 tons.
		48,193 tons.

During the year, first-class hoisting-works have been erected at the mine, consisting of a steam-engine, (size) 18 by 27 inch cylinder, with the necessary gearing attached; two sets of boilers—one set (old) 48 inches diameter, 14 feet long, one set (new) 54 inches diameter, 16 feet long—which has capacity to develop and work the mine to a depth of 2.500 feet, unless water in considerable quantities is met with, in which case additional machinery will be required. The new buildings erected at the mine are the main engine-house, boiler-house, blacksmith-shop and coal-house, together with improvements on the carpenter-shop and ore-house. The Lightner shaft has attained a depth of 1,070 feet. To the depth of 900 feet it consists of but two compartments; at that point, a third compartment was added. The rock in the bottom of the shaft presents the same general characteristics of all the material through which the shaft has passed from the surface down, still being in a quartzite formation. The ninth level (850 feet) is the lowest level on which the vein has been cut. The prospect in a winze being sunk from this level is very encouraging.

The 30-stamp mill has been changed from dry to wet crushing; two pans have been added to the amalgamating department. The engine has been taken up and reset in a very substantial manner. At the 20-stamp mill two new 54-inch boilers have been put up, which afford ample steam for amalgamation and to run the entire machinery of the mill. Automatic battery-feeders have been placed at each and every battery at both mills. Both mills are in as high a state of efficiency as can be desired. The water-pipes leading from the spring to the mills (a distance of one and a quarter miles) have been placed under ground, by which a regular supply of water is furnished the mills. The Nevada Central Railroad has been of great benefit to the company in affording cheap and sure transportation of ore at all seasons; a saving thus far of about thirty-five thousand dollars as compared with team rates has been made.

The first series of ore deposits seems to be about exhausted, and the works of exploration as yet have failed to develop other valuable bodies of ore. But it is highly probable that this great Panaca fissure, which has produced its millions of treasure, and made for the Raymond and Ely a world-wide reputation, will, at some depth, yield other deposits.

RAYMOND AND ELY MINING COMPANY.

Statement of ore produced, shipped, cost of extracting the same, &c., for year ending December 31, 1873.

Months, 1873.	Ore extracted.		COST.							ORE SUMMARY.									
			Extraction.		Prospecting and dead-work.		Repairs and improvements.	General.	Total.	Ore shipped.		From what source.							
												Panaca mine.		Burke Ming dump.		Creole mine.		Panaca dump.	
	Tons.	Pounds.	Labor.	Materials.	Labor.	Materials.				Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.
January	2,400	......	$24,020 50	$9,230 48	$19,762 50	$6,768 79	$2,480 03	$1,587 66	$63,840 96	2,335	610	2,242	240	......	......	93	370	......	......
February	1,900	......	15,640 00	5,087 35	17,908 50	3,231 70	3,853 37	1,343 04	47,063 96	1,641	40	1,641	40	......	......	....	....	......	......
March	2,700	......	21,472 25	6,029 44	23,951 25	5,091 79	5,380 89	1,512 25	63,437 87	3,936	140	3,023	1,350	......	......	....	....	912	700
April	2,286	1,100	19,502 50	4,638 90	19,615 17	3,940 24	2,944 60	1,496 22	52,137 63	3,395	1,410	2,286	1,100	......	......	....	....	1,109	310
May	1,800	......	12,598 25	5,302 01	16,075 41	3,550 21	8,383 50	2,354 71	48,258 09	3,342	1,610	1,800	......	......	......	....	....	1,542	1,610
June	1,463	610	9,479 33	2,360 58	10,323 24	2,069 24	27,915 95	2,228 89	54,377 23	3,058	710	1,463	610	......	......	....	....	1,595	100
July	......	......	......	......	2,470 00	......	28,977 47	1,846 65	33,294 12	2,179	200	......	......	......	......	....	....	2,179	200
August	868	......	13,070 00	6,900 00	12,029 00	1,731 00	4,205 34	1,283 33	30,218 67	1,656	......	868	......	......	......	....	....	788	......
September	1,500	......	16,150 00	6,046 74	11,491 00	4,840 00	......	1,793 33	40,321 07	1,382	......	1,382	......	......	......	....	....	......	......
October	1,763	......	21,493 00	9,163 81	18,230 25	6,000 00	1,431 00	1,483 33	57,801 39	1,881	......	1,881	......	......	......	....	....	......	......
November	1,201	......	20,784 50	7,140 34	14,781 00	7,218 84	565 00	1,283 33	51,773 01	1,201	......	1,201	......	......	......	....	....	......	......
December	944	......	17,647 00	3,736 59	15,049 00	3,495 16	6,445 54	1,393 10	49,338 70	1,016	......	944	......	72	......	....	....	......	......
Total	18,825	1,710	191,851 33	65,636 24	181,686 32	47,936 97	92,582 60	19,605 74	509,299 39	27,024	720	18,732	1,340	72	......	93	370	8,126	1,010
Average per ton, ore extracted	......	......	10 10	3 48	9 65	2 54	4 93	1 04	31 83	......	......	......	......	......	......	....	....	......	......

RAYMOND AND ELY MINING COMPANY.

Statement of bullion produced for account of the company for year ending December 31, 1873.

Months, 1873.	NO. OF BARS.		Weight, troy ounces.	FINENESS.		Value per ounce.	VALUE.			BY WHOM REDUCED.	
	From—	To—		Gold.	Silver.		Gold.	Silver.	Total.	Company's mills.	Outside mills.
				1000ths.	1000ths.						
January	2755	2922	316, 510. 00	002. 64	943	$1. 273	$11, 797 75	$263, 779 16	$275, 576 91	$264, 601 30	$10, 975 61
February	2923	3037	114, 423. 00	002. 67	920	1. 244	8, 503 01	183, 564 12	192, 067 13	166, 225 63	25, 841 50
March	3038	3213	236, 701. 50	002. 76	884	1. 202	13, 953 47	270, 636 14	284, 589 61	279, 597 38	4, 992 23
April	3214	3338	231, 400. 50	003. 09	897	1. 220	14, 787 43	268, 582 74	283, 370 17	254, 179 37	29, 190 80
May	3339	3533	194, 341. 00	003. 21	893	1. 219	12, 892 10	224, 222 34	237, 114 44	209, 604 79	27, 509 65
June	3534	3684	204, 597. 00	002. 32	771	1. 044	9, 817 57	203, 882 72	213, 700 29	179, 860 63	33, 839 66
July	3685	3777	126, 321. 50	002. 50	792	1. 076	6, 535 51	129, 387 97	135, 923 48	132, 997 04	2, 926 44
August	3778	3897	102, 586. 50	001. 73	932	1. 241	5, 806 58	196, 027 53	201, 834 11	201, 834 11	....
September	3898	4000	139, 745. 00	001. 99	904	1. 209	5, 733 91	163, 203 75	168, 957 66	168, 957 66	....
October	4001	4092	122, 625. 00	002. 17	829	1. 117	5, 416 26	131, 547 17	136, 963 43	136, 963 43	....
November	4093	4161	93, 437. 00	002. 34	770	1. 043	4, 522 00	92, 978 70	97, 500 70	97, 500 70	....
December	4162	4258	127, 365. 50	001. 44	813	1. 081	3, 796 42	133, 957 93	137, 754 35	137, 754 35	....
Total	2755	4258	2, 010, 053. 50	002. 49	871	1. 177	103, 582 01	2, 261, 770 27	2, 365, 352 28	2, 230, 076 39	135, 275 89

In regard to the saving effected by the use of the railroad now in operation between Pioche and Bullionville, the superintendent of the Raymond and Ely reports:

ALPHEUS BULL, Esq.:

There was hauled last spring, from January 1 to July 31, by teams, 17,723$\frac{920}{2000}$ tons, at $6.69		$118, 738 26
By railroad, June 14 to December 31, 6,784$\frac{1800}{2000}$ tons, at $2.75	$18, 658 47	
2,516 tons, at $4	10, 064 00	
		28, 722 47

Being an average of $3.09 per ton.

The difference between this average and that of the ore hauled by teams amounts, on the ore hauled by the railroad, to $33,483.24, actual saving to us during last six months.

Had the ore been hauled by the railroad during the first six months, we would have made a saving, at the rate of $2.75 per ton, of $69,830.43; at the rate of $3.09 per ton, $63,804.45; at the rate of $4 per ton, $47,676.18, on the ore hauled by the teams.

The account of the railroad on our books stands as follows:

Ore hauled, 6,784$\frac{1800}{2000}$, at $2.75	$18, 658 47
2,516, at $4	10, 064 00
	28, 722 47
Paid December, account November	6, 000 00
Amount due January 5, 1874	21, 722 47
Paid January 10, account December	4, 064 00
Amount due at this date	17, 658 47

Financial statement of the Raymond and Ely Company for the year ending July 15, 1874.

RECEIPTS.

Cash on hand, as per last annual statement		$148, 578 58
From bullion yield of the mines	$2, 358, 906 87	
Less reclamations for variations in assay	19, 542 47	
		2, 339, 364 40
From milling labor:		
Weighing ores for other mines		868 82
From mining supplies:		
Sales of supplies at Pioche		336 00
From milling supplies:		
Sales of supplies at Bullionville		1, 628 09
From mining labor:		
Unclaimed drafts drawn for accounts of various pay-rolls during a period of 15 months, canceled		1, 079 50
From insurance:		
Premiums returned by underwriters, on insurance of thirty-stamp mill, on its being changed from dry to wet crushing		585 80

From water-works:	
Water sold to other mines	$1,008 50
From mill improvements:	
For one steam-boiler sold to the Newark S. M. Company.	1,254 46
Sales of ore at the mine	527 25
From mill repairs:	
For one steam-drum sold to the Newark S. M. Company..	175 00
Superintendent's drafts:	
Advised but not yet presented	13,225 25
Western Union Telegraph Company:	
Advances returned by service	836 60
Overdrafts on the Bank of California	89,277 84
	2,598,746 09

DISBURSEMENTS.

For purchase of property and claims	$288,173 55	
For Hermes Mining Company	3,064 80	
For Pioche Phœnix Mining Company	3,180 00	
For Meadow Valley Extension Mining Company	1,667 55	
		$296,085 90
For law expenses		289,849 07
For mining:		
Wages paid to miners	383,529 16	
Supplies for the mines	128,794 96	
Freight on supplies	1,778 41	
Contingent mine expenses	10,856 26	
Mine repairs	960 97	
Salaries of superintendents and clerks	13,724 96	
		539,644 72
For improvements at the mine	55,876 14	
Freight on improvements	6,298 52	
		62,174 66
For milling:		
Wages paid to employés	131,091 90	
Supplies for the mills	194,784 03	
Freight on supplies	24,356 03	
Contingent mill expenses	5,316 70	
Salaries of the superintendent and clerks of the mills	12,000 00	
Paid to custom mills	58,006 39	
Mill repairs	2,704 55	
		428,259 60
For improvements at the mills		2,180 49
For ore-hauling from the mines to the mills		125,104 76
For taxes:		
On real estate and personal property	7,434 89	
On bullion yield of the mines	51,357 83	
		58,792 72

Charity (disbursed by the superintendent)		$575 00
Magnet Mining Company		140,439 67
For advances to Nevada Central Railroad		139,502 00
For discount on bullion		78,869 02
For dividends		390,000 00
For interest and discount		12,184 75
For office salaries		8,990 00
For insurance on the mills		2,530 00
For trustees' fees		1,220 00
For general expenses		2,139 90
For office expenses	2,600 15	
Less rents received from sub-tenants	430 00	
		2,170 15
H. H. Day, superintendent		9 00
Superintendent's drafts—outstanding last annual statement, and paid during the year 1873		18,004 68
Total disbursements		2,598,746 09

ASSETS.

Mines:	
Improvements—offices, houses, hoisting-works, &c	$82,700 00
Supplies	31,308 95
Mills:	
Thirty-stamp mill	135,000 00
Twenty-stamp mill	70,000 00
Water-ditch, pipe, and privilege	10,000 00
Offices, shops, animals, tools, &c	11,850 00
Supplies	96,079 72
Ores and tailings	470,392 00
Advances to railroad and mining companies	386,206 47
Total assets	1,293,537 14

LIABILITIES.

Drafts, freight, and bank-accounts	$125,225 56

CHAPTER III.

IDAHO.

For the larger part of the notes on Idaho I am indebted to Mr. A. Wolters, the accomplished superintendent of the United States assay-office at Boise City. As predicted in my last report, the bullion production of the Territory shows this year a considerable decrease if compared with that of last year, though the very gradual melting of the snow furnished the placer diggings with a steady supply of water and made the season a favorable one. The complete exhaustion of the placers is only a question of time. For every well-paying claim worked by white men, we find at present probably not less than five or six which return profits only to Chinamen, and a few camps are almost exclusively worked and owned by them. Of the whole production of the Territory, which Mr. Balentine, general agent of Wells, Fargo & Co., puts at $2,500,000, more than two-fifths must be credited to the quartz-mines of Owyhee, Alturas, and Boise Counties; and the future welfare of the country, so far as the production of the precious metals is concerned, depends solely on the mineral-bearing veins, which are found in large numbers and of good quality in every county. The lack of facilities for cheap transportation, mentioned in the last report, still continues, with no prospect of an immediate change for the better. The Portland, Dalles and Salt Lake Railroad, which secured the right of way and use of stone and timber on the public lands during the last session of Congress, has not done anything, and probably will not do anything. So far the company has not succeeded in disposing of its bonds; the Idaho legislature has also failed to hold out substantial inducements; and thus the great obstacle in the way of profitable quartz-mining still exists, involving high prices of labor, materials, and provisions. As a natural consequence, only the very best mines are worked, and not even all of these with decided financial success.

OWYHEE COUNTY.

For the report of progress and product from the Owyhee district I am indebted, as in former years, to Mr. J. M. Adams, of Silver City. The history of the district shows a very dull time through the months of January, February, March, April, and May; but the remaining part of the year has been full of activity and prosperity. The reason for this was that many of the mines only found good bodies of ore about January 1, 1873, and several months of opening and dead-work were necessary before the deposits of ore were exposed so as to be taken out economically. The remainder of the year, however, has been very prosperous.

At this time (January 31, 1873,) the Golden Chariot shaft is down 720 feet; the Minnesota shaft 611 feet; and the sixth level of the Chariot and the seventh level of the Minnesota are connected, the two mines having been proved one. The Ida Elmore shaft is down 960 feet, and is within 35 feet of the future eleventh level, while the tenth level is being driven north. The War Eagle shaft is 653 feet in depth; the sixth-level drift, both north and south, is in splendid ore, and they are sinking for the seventh level. The shaft of the Empire is down 460 feet, within 70 feet of the future fifth level, and work in all parts of the mine is being vigorously prosecuted. The Mahogany shaft is 732 feet deep, and is within 30 feet of the ninth level.

Many of the mines are being opened up, with the view of large results next summer and fall. There is a rich deposit of ore in each of the following mines: Golden Chariot, South Chariot, War Eagle, and Empire; and large bullion yields may be looked for next summer. Thanks are due Mr. Manuel Eissler, for collecting part of these and the following statistics:

Statement of the operations of mines and mills in Owyhee district, Idaho, for the year 1873. Reported by J. M. Adams.

Name of mine.	Where worked.	No. tons ore worked.	Product.	Yield per ton.
Mahogany	Cosmos Mill	2,698	$125,551 38	$46 97
Golden Chariot	Owyhee Mill Ida Elmore Mill	2,085 3,038	348,032 75	67 93
Empire	Owyhee Mill	1,938	45,000 00	23 22
Minnesota	Owyhee Mill	5,312	237,225 01	44 46
Ida Elmore	Ida Elmore Mill	505 450-2000	22,567 14	44 72
Morning Star	Cosmos Mill	80	3,563 82	44 54
Illinois Central	Cosmos Mill	430	24,277 96	73 45
War Eagle	Sundry	615	21,698 02	35 28
South Chariot	South Chariot Mill South Chariot Mill	300 550	11,678 61	38 93
Red Jacket	Ida Elmore Mill	400	38,652 17	40 68
Outside claims and slums	Sundry	700	50,000 00	71 43
Placer claims			74,000 00	
Total number tons worked		18,551 450-2000	1,002,246 86	

	Tons.
Amount of ore worked in Owyhee Mill, including sundries and slums	9,880
Amount of ore worked in Cosmos Mill, including sundries and slums	3,583
Amount of ore worked in Ida Elmore Mill, including sundries and slums	4,043$\frac{450}{2000}$
Amount of ore worked in South Chariot Mill, including sundries and slums	850
Amount of ore worked in arrastras and Black's Mill, in Flint.	195
Total	18,551$\frac{450}{2000}$

In South Mountain district, which was fully described in my last report, the want of capital has prevented all improvements. The mines are still mostly held by the original owners, and no foreign capital has come into the district to help develop the mines or to build smelting-works. The principal reason is the great distance of the district from the railroad, which deters capitalists at once. In spite of this remoteness of the location, it is, however, quite feasible to conduct mining operations here profitably, as the smelting ores found are far richer than is usually the case in western lead-districts, and I hope that another year may relieve this really meritorious camp.

ALTURAS COUNTY.

Rocky Bar.—The principal mining camp in the county is Rocky Bar, on the Boise River, about one hundred miles east from Boise City. A large number of gold-bearing veins are here grouped together on a very small area; and while nearly all of them carry strong bodies of ore, which, under more favorable circumstances, should insure large profits to the owners, there are a few which have acquired a good reputation, even beyond the limits of the Territory. At present this district, like all the others, has to suffer from the effect of high freights, high wages, and cost of living; besides which there is a lack of well-constructed and well-managed mills, for cheap and efficient treatment of the ores.

The leading mine of the camp is the Ida Elmore. It is situated in the gulch, about half a mile above the town, and is owned by the Pittsburgh Gold Mining Company, of Pittsburgh. The course is northeast and southwest, dip to the north; crevice 4 feet wide; gangue-matter, quartz, and decomposed granite; country-rock, granite and gneiss. A shaft has been sunk right in the gulch, and at a depth of 100 feet levels have been run east 170 feet and west 100 feet, showing all the way a solid vein of ore about 2½ feet in width, consisting of hard bluish quartz, with some iron pyrites finely intermixed, and plenty of free gold visible to the naked eye. In the fall of 1872 50 tons of ore were extracted and worked in the mill, yielding about $4,000; but, owing to the location of the shaft, the water seriously interfered with the working of the mine until a 6-inch pump had been put up. This, of course, caused considerable delay and expense, and, combined with some circumstances in the management, involved the company heavily. As funds to pay the debts were not forthcoming, work was suspended until this summer. Since then work has been carried on vigorously and steadily, and a large amount of ore has been mined, which has yielded in a second-rate stamp mill from $80 to $100 per ton. The present superintendent, Mr. I. Newton, intends to put up a heavier pump, sink the shaft 50 feet deeper during the coming winter, and then run another pair of levels, while stoping will be continued above the present levels. At present, (November, 1873,) a lot of 100 tons of rich ore is being crushed, which will probably finish mill operations until next spring, the mill not being in condition for convenient working during the winter months. The ore extracted during the winter will be stored, and next summer there ought to be a sufficient amount on hand to keep the mill running steadily.

The Idaho lode runs northeast and southwest, and dips about 50 degrees north. The crevice averages about 3 feet in width, with a pay-streak of bluish quartz 2 feet wide. There has been more work done on this vein than on any other in the camp. It consists altogether of cross-cuts and levels. The first cross-cut, 120 feet long, intersects the lode at a depth of 60 to 70 feet, at a point from which a level 400 feet in length has been run, and the ore above is worked out. At 100 feet below this level the lode has been opened by a second cross-cut 400 feet long, and another level has been run 200 feet along the vein. Above this the ore has been stoped out to an average height of 25 feet, the remaining ground between the two levels being apparently of a poorer quality. The lode has always borne a high reputation, and has yielded large amounts of very good ore; but the present workings are in poor ground, and it will require some development before the mine will again be in condition for steady production. The last 13½ tons of ore worked yielded at the rate of $97.50 per ton.

In close proximity to the foregoing, and running parallel to it, is the Vishnu lode. It dips considerably north, though not as much as the Idaho. On the surface the well-defined crevice is 4 feet wide, with a pay-streak of 10 inches, which has yielded at the rate of $100 per ton. A shaft has been sunk on the lode 80 feet deep, and the ore-vein has been found to widen steadily, until it was 2 feet wide in the bottom of the shaft. At a depth of 150 feet below the surface, reached by a cross-cut tunnel 234 feet in length, the crevice is 14 feet wide and the ore-vein about 4 feet, consisting of decomposed crevice-matter, with seams of iron pyrites and gray antimony through the whole mass. The ore taken from the lower stopes is not as rich as that obtained from the shaft. It averages about $60 per ton. This fall the lode has been leased by J. Reeser and Frank Strauss, each having one-half, and paying, respectively, $1,500 and $1,200 for the time of six months. By many this lode is considered a branch of the Idaho, but, so far, the fact is not established.

The Iowa lode runs northeast and southwest, and dips strongly to the north on the surface, but less strongly at some depth. The development consists of one cross-cut tunnel 90 feet long, at the end of which a winze has been sunk 40 feet deep, and another cross-cut, intended to tap the lode from 60 to 70 feet deeper, which so far has been driven 190 feet. The crevice is well defined, and carries some good-looking ore.

The Crown Point or Bedrock lode, running northeast and southwest, dips north, has a drift-tunnel on the vein 150 feet long, which shows a crevice from 4½ to 5 feet wide, with a pocket of ore 2 to 3 feet wide.

The Golden Star lode is owned and worked by the Valley Gold-Mining Company, which has recently struck the lode by a cross-cut tunnel, developing a crevice from 3 to 4 feet wide, with a good body of ore. Some of it has been treated in the company's mill; results unknown.

A few miles east of Rocky Bar are the General Grant and General Sherman lodes, owned by A. & J. Pfeiffer. The former looks very well on the surface, carrying a strong body of very rich ore. A tunnel started above the level of the creek and intended to be run on the vein has lost the crevice, and nothing was being done at the time of Mr. Wolters's visit. It is now said to be the intention of the owners to work both lodes during the winter.

Thirteen miles from Rocky Bar, on the Bonaparte Hill, is the Bonaparte lode, owned by the New York and Ohio Gold-Mining Company. The lode is well defined and carries a strong vein of ore, which assays very well. A large amount was mined during the summer and treated in the company's mill. In the latter part of October, work was abandoned because the bullion resulting from the working of the ore proved to be only matte, not containing enough precious metals to pay the express charges. As such a thing can only be caused by ignorance in the milling process, it is but just to state that the company's superintendent was, against his will and in spite of his own statement that he did not understand pan-amalgamation, ordered by the company to manage that department. It seems to be difficult for associations of eastern capitalists, otherwise sensible business men, to learn that in mining and metallurgy, as much as in book-keeping, banking, commerce, or manufactures, some one concerned in the management must understand it theoretically and practically. The effect of repeated failures, for want of observing this simple principle, is not merely the loss which those incur who have deserved and invited it, but greater harm to the country than to them. The fact of failure will always become known, but outsiders will seldom learn anything about the true reasons; and thus the mines and the district are often unjustly disparaged, and their development is hindered or defeated.

There are four mills in Rocky Bar, three run by steam and one by water-power. Two of the mills, that of the Pittsburgh Company and the Idaho Mill, are about worn out and hardly in a fit condition to be used any longer to advantage.

The Pittsburgh Company now crushes its ore in the old Waddingham Mill, which contains 10 stamps and copper tables, no pans and no concentrators. The mill of the Valley Gold-Mining Company contains one Dodge crusher with a pair of Cornish rollers and two large stone arrastras. Outside of these mills there are four or five arrastras.

Atlanta.—This camp is situated about twenty miles due east from Rocky Bar, on the Middle Boise River. Though at present rather dull, the place is destined to become prosperous as soon as the price of wages and materials shall be somewhat decreased and the facilities for cheap transportation improved.

The best known and perhaps the most valuable lode of the district is the Atlanta. No work has been done on it since my last report, until this fall, when a lot of 30 to 40 tons of ore was taken out and worked at the mill, paying at the rate of $50 per ton. At the time of Mr. Wolters's visit the mine was in very bad condition, there being no reserves worth speaking of, and it will require considerable development to put it in good working-order for steady production. It has been bonded for the last three or four years to parties who have been endeavoring to dispose of it in the English market. The price asked is said to be large. On account of the expected sale of the property the proprietors probably have not cared to expend any money in opening new ground. Operations have been confined to robbing the lode of all the good ore in sight; and owing to this system of mining, the mine is now in such a shape that a stranger, unacquainted with its early history and the extraordinary richness of its ore, would be puzzled to account for the high estimate of its value put forward by its owners.

On the other side of the gulch, about half way between the Atlanta and the town, is the Leonora lode. A cross-cut tunnel has struck the lode, and shows a crevice 6 to 8 feet wide, with a pay-streak of 3 feet. During this season the mine has not been worked.

The Stanley lode has been worked a little this summer, and some 40 or 50 tons of ore have been mined, which yielded moderately in the mill. The ore was obtained by sinking a shaft from the surface, the crevice having been lost in the adit started above the level of the creek. Several samples of ore from this mine were assayed, and seem to indicate an average value of $50 to $60 per ton for the whole.

The Tehama lode, discovered last spring, was being developed at the time of Mr. Wolters's visit, by a shaft which showed a large, well-defined crevice 8 feet wide, with a strong body of good-looking silver-ore in it. Since then some ore has been tested in the mill, with very satisfactory results.

Right in the gulch a new lode was discovered this summer, which carried about one foot of exceedingly rich-looking ore, ruby and native silver being visible in a good many pieces. The lode has been leased by Messrs. Lantis Bros., Nelson Davis, and others, with the privilege of buying it for a stipulated amount at the expiration of the lease.

On both sides of the gulch, as well as on the summit and the slope of the mountain toward Yuba Creek, there are numerous other lodes, most of which look very promising, but lack sufficient development to justify an opinion on their value.

There are three mills in the camp, each containing 10 stamps. The Greenback Mill, situated on the river, is driven by water-power, and contains two of Wheeler & Randall's excelsior pans. It is not used now. The Monarch Company, owning the larger portion of the Atlanta lode, has also a water power mill with 8 Varney pans. The third mill is owned by the Gold-Mining Company of Yuba. It contains six Varney pans and an 18-horse-power steam-engine. The latter does not, however, meet the wants of the mill; and it is the intention to take a larger engine and boiler over to Atlanta from the plant of a 20-stamp mill owned by the company on the Yuba River, which has never been put up.

Atlanta district enjoys many natural advantages. The mountains are steep, and the lodes mostly cross them, so that mining operations can be pursued by tunnels on the veins, gaining depth rapidly. They are covered with a luxuriant growth of timber, and the valleys with splendid grass. South Boise and Yuba Rivers furnish ample water-power for many mills, and hot springs in Atlanta keep the South Boise near the town from freezing during the winter. These advantages are, however, to some extent counterbalanced by the isolated situation of the place and the roughness of the country, which so far has prevented the building of even a good wagon-road of easy grade. The present road follows the ridges, and is generally in a very bad condition. If ever a railroad should be built from Ogden, or some other place in that vicinity, to the Columbia River, it is probable that it would run through Big Camas Prairie; in which case Atlanta would be only fifty-five miles and Rocky Bar thirty-five miles from the road. Connecting the ranges by good wagon-roads or a branch narrow-gauge road with the main line, would soon put them in flourishing condition, and materially swell the bullion-product of the Territory.

Red Warrior district.—This district is two miles from Rocky Bar, in a westerly direction. The only well-developed mine is the Wide West, owned by McNally & Thomas. Its course is northeast and southwest; dip small and variable. Crevice between 4 and 5 feet wide, with a pay-streak of from six to thirty inches. The discovery is nearly on top of the hill, and was made on one of the two branches of the vein, which meet about 40 feet lower down. Below the junction a cross-cut tunnel was driven 100 feet, when it struck the vein 50 feet below the surface. A level 300 feet long was run from here on the vein. A second cross-cut, 250 feet long, opened the lode 60 feet below the first one and was extended 350 feet on the vein; and a third, 200 feet long, gained 87 feet more depth, and was also continued in a drift 350 feet on the vein. From this level a winze has been sunk 18 feet deep. Mr. Wolters found work in progress on the right branch of the lode near the surface, where a twelve inch vein of very good ore could be observed through the whole length of the open cut. This ore yielded as high as $75 per ton in the mill. Between the first level and the surface there are about three hundred tons of similar ore left; between the first and second levels the ground is all stoped out; but there remains a large piece of ground between the second and third levels where the stopes are only 60 feet long and 40 feet high. This ore, though not nearly as rich as that in the open cut, contains enough gold to yield a moderate profit above all mining and milling expenses. In the bottom of the shaft is a solid vein of pay-quartz 2 feet wide. After Mr. Wolters's visit, the shaft was sunk a little deeper; and the vein is reported to have nearly doubled in width and to yield ore equal in quality to any ever obtained from the mine. By starting another cross-cut tunnel above the level of the creek the mine can be opened and drained for 150 feet to 200 feet below the third level, and the tunnel can, by means of a short tramway, be directly connected with the mill. The present cost of hauling ($1 per ton) would thus be avoided; the mine would be drained without any expense whatever, and an immense body of ore would be made available. But the present owners cannot afford such an outlay for dead work.

The company owns a mill, which stands in the gulch at a small distance from the mine. It contains ten stamps of 650 pounds weight each, making seventy drops per minute, of ten to eleven inches, capacity fifteen to sixteen tons per diem. The gold is caught on plates in the battery and on copper tables. The tailings are collected in a large reservoir just below the mill, and saved for future concentration and treatment. The mill is small but substantially built, kept in good order and more than sufficient for all present necessities. During the last two years it has yielded $120,000, nearly all from ore out of the company's mine. A concentrator and pan for working tailings can be put up in the mill without enlarging the building, and would save the cost of bringing the tailings out of the reservoir back into the mill. The power is furnished by a fifteen-horse-power steam-engine.

The following figures, which Mr. McNally kindly furnished from the company's books, show that the value of the ore has always varied very much:

No. of tons.	Yield.	No. of tons.	Yield.
120	$2,639 26	165	$5,502 00
135	5,247 49	160	2,037 00
162	3,308 43	213	3,865 75
120	2,030 33	260	3,899 00
142	2,000 00	228	3,153 50
140	3,500 00	28	1,491 00
115	5,312 00	20	1,200 00
113	1,728 00	22	1,795 50
150	3,577 00	12	2,534 00

Making a total of 2,305 tons, yielding $54,830.26, or at the rate of $23.79 per ton.

A few hundred yards west is the Avalanche lode, running parallel to the Wide West. The crevice is from 4 to 5 feet wide, with a strong body of rich bluish quartz, averaging over a foot in width. The dip is very slight. The mine is owned by John Thomas, E. E. Clough, and Edward Phillips, who have been working it steadily through the season, ever since the lode was discovered. They had fifty-nine tons of ore worked in the Wide West Mill, the first lot, of ten tons, yielding $703, the last, of forty-nine tons, about $4,500. Work will be continued through the winter.

Outside of these lodes there are many others which have been lying idle and are mostly not developed or not in condition for examination. Nearly all of them have well-defined crevices, with strong bodies of ore similar to that of the Wide West, and probably of about the same average value. Wakefield & Son have recently commenced work on the Tenino, and John Tonkin on the Hardup, both very promising veins.

Mr. C. Jacobs, of Boise City, owns several lodes here. One of them, the Victor, is somewhat developed, and a very strong vein; the shaft, however, which I believe is 80 feet deep, was full of water last summer, and thus no data can be given. Mr. Jacobs also owns a very fine and substantially built 20-stamp mill, with an excellent fifty-horse-power engine.

The principal placer-mines of the district are on the Middle Boise River and on Hardscrabble Creek. The latter are owned by Messrs. A. & J. Pfeiffer, of Rocky Bar, and yielded about $15,000 to them last season.

The whole production of the county is probably from $100,000 to $125,000, of which about one-third came from quartz lodes. For the next year, the amount will probably be much larger; as some of the best lodes, but little worked last year, are now turning out large amounts of bullion. During the five months from July 1, 1873, to November 30, the United States assay-office at Boise City received over $50,000 from Rocky Bar, while the amount furnished during the whole year ending June 30, 1873, was only $35,000.

This summer a new mining district was located on Wood River, where a number of silver and gold bearing galena veins have been discovered, which, to judge from the character of the ore, are very similar to those of South Mountain and Owyhee. Three samples assayed by Mr. Wolters gave the following results:

	I.	II.	III.
Gold............	$76.49	$4.13	$32.04
Silver...........	100.40	101.76	84.94
Lead............	65 per cent.	69 per cent.	51 per cent.

The ore was coarse galena with carbonate and oxide of lead and oxide of iron, and very pure. The lodes are about ninety miles south of Rocky Bar and about as far north from Fort Hall. The old overland road passes within a short distance of them.

BOISE COUNTY.

Banner district.—Nothing has been done here since my last report in the different mines; but there will probably be great activity next season, and the Banner and Wolverine lodes will also be worked during the winter. G. W. Crafts, the principal owner in these two lodes, moved his mill from near Idaho City over to Banner in September, and will take out as much ore as possible to have a good supply on hand when the mill is finished. The mill contains 20 stamps and a very good new engine. Roasting furnaces and pans will be put up next spring; and the owner expects to keep it running steadily to full capacity. In this, however, he may find himself disappointed. There are certainly a great many lodes discovered in the district, but the work done on most of them does not amount to much, and a developed mine does not exist there at all. The Banner and Wolverine, the two best lodes of the camp, are both well-defined veins, carrying large bodies of tolerably good, and small amounts of very rich ore; but neither of them is in a condition to furnish a large and regular supply, nor is there any possibility of developing them so far during the winter that they can supply even half the capacity of the mill. There is no doubt, however, that the erection of the mill will give a new impetus to mining in that camp, as it supplies miners with a market for their ore and a chance to test the value of their lodes. This may be the means of bringing out the district and making it a prosperous mining-camp; Mr. Crafts is certainly entitled to considerable credit for his enterprise, though his profits may be delayed.

Near Idaho City the Keystone lode has been worked for a short time, but after running a considerable quantity of ore and finding that the resulting bullion did not pay for crushing, work was abandoned. It is reported that no sinking was done on a good vein of ore which appears in the mine, and that failure was the natural result of a desperate attempt to make wall-rock pay.

Quartzburg.—In this district the Gold Hill Company has been steadily at work during the whole year. The lower level on the west extension of the Gold Hill lode has been extended 800 feet. It was started on a level with Granite Creek, runs under a small hill a couple of hundred feet in height, and at the time of inspection the heading of the level was about 28 or 30 feet below the bed of another creek which runs at the foot of the other side of the hill. Since then it has been continued some distance into the next mountain; the ore has considerably increased in quantity, and the prospects of the mine are better than ever. The ground in the first hill is nearly exhausted, all the stopes being now near the surface, and having already broken through in some places. The crevice through the different stopes was from 2½ to 4 feet wide, the ore occurring in seams consisting of quartz, iron pyrites, and gray antimony, and mostly containing plenty of free gold.

In the old Gold Hill several stopes were worked between the third and fourth levels, and the heading of the lowest level is now being driven in very good ore.

The east extension of the Gold Hill is for the most part owned by Eissler & Co. They have run a cross-cut tunnel between 400 and 500 feet long, intersected the lode at a depth of about 180 feet, and raised a shaft from the tunnel to the surface. To the depth of 50 feet the ore is decomposed, and the vein considerably broken up. At that point it reverses its dip, and a vein of solid ore, averaging 36 inches in width, extends down to the tunnel. It is an intimate mixture of decomposed gangue-matter, iron pyrites, and antimony, easily mined without any blasting. A sample taken across the whole width of the pay-streak assayed—

	Per ton.
Gold	$77 52
Silver	11 96
Total	89 48

The lode is not worked now, because the owners have no mill to treat their ore. Negotiations have been going on this fall to raise enough capital to buy the Keystone Mill, near Idaho City, and take it over to the lode, and further, to put the mine in good shape for working by running levels; but up to this time the owners have not received any encouragement, though their propositions were very fair, and the mine certainly looks promising.

A couple of hundred feet north of the Gold Hill is the Hawley lode. It is claimed by Mootry and others as the Lone Star lode, and a lawsuit has been carried on for several years to determine the ownership. At present it is pending in the Supreme Court. The lode is worked on the surface, and near it, by adits, the vein lying almost flat. A cross-cut tunnel has been run quite a distance, to intersect the lode 60 to 65 feet below the upper level, and a winze has been sunk to connect the two. The ore is decomposed quartz, with free gold, and very rich; and, though in absence of a mill, the owners merely wash their ore in sluice-boxes, and lose, of course, a good deal, they have taken out considerable money.

The Gold Hill Company's mill has been running steadily the whole year, crushing daily from 35 to 40 tons of ore. The concentrated sulphurets have been worked in pans, with satisfactory results. Late in the season, an arrangement was effected between the company and a party from San Francisco, according to which the former agrees to furnish from 6,000 to 10,000 tons of sulphurets and 10 horse-powers from the engine, for which the latter will pay $6 per ton.

For placer-mining the season was a very favorable one through the whole basin; since, owing to the cool weather in April and May, the snow melted very gradually and furnished a uniform amount of water. The assay-office of C. W. Moore & Co. bought and assayed nearly a million dollars' worth of gold; and as almost all the product of the Boise Basin finds its way to their office, that amount may be considered the total production of the placers.

IDAHO COUNTY.

Last fall and winter work was continued on the Rescue lode by G. Gambel, and some rich ore was obtained in sinking the shafts from the lower level further down. This spring the litigation about the lode resulted in favor of the plaintiff, A. Leland, of Lewiston, and since then nothing has been done, as the large amount of water carried by the vein, and the necessity of sinking the shaft deeper, to open the mine, made the erection of good substantial hoisting-works necessary. The Rescue Gold Mining Company, A. Leland, president, was then formed, and machinery was ordered in San Francisco. Unfortunately, however, it was shipped too late to be packed over to Warrens, winter having already set in when it arrived at Lewiston. As early as practicable in the spring it will be taken over and work will be resumed.

The Charity lode has been worked steadily; but the results are not known.

The placer-mines of this and adjoining counties yielded about $300,000.

CHAPTER IV.

OREGON.

The annals of mining enterprise in the State of Oregon during the past year have been uneventful. Mr. Valentine, the accomplished superintendent of Wells, Fargo & Co.'s Express business, estimates the gold product of the State at $1,376,389, a sum which seems to me a close approximation. On the same authority, Washington Territory (from which I have no returns) has produced $209,395. The western districts, once the scene of a busy placer-mining industry, have relapsed into comparative idleness, though the ancient diggings are still reworked here and there by Chinese, and now and then a feeble move is made, under the inspiration of the great success of hydraulic workings in California, to "bring in water." The middle districts, on the tributaries of the John Day River, with Cañon City as their commercial center, may be said to remain about *in statu quo;* at least, my correspondents report neither progress nor noteworthy decline. The principal activity has been manifested in the eastern district, and particularly in Baker County. I am indebted for the latest information from that section to an esteemed correspondent, Mr. E. W. Reynolds, of Baker City.

The Virtue mine, on the Rockfellow and Union lodes, a few miles from Baker City, has been repeatedly described in former reports. The favorable opinion which I expressed after a personal examination of this mine in 1869 has been steadily confirmed by later developments. It is now reported to be looking better than ever, showing a large vein of good quality at the depth of 500 feet below the top of the first shaft. The width of the vein is said to be 2½ feet, and the yield of the rock $20 to $30 per ton. The company levied an assessment of 75 cents per share during the year, for the purpose of defraying the expense of erecting a new mill and machinery at the mine. The old mill was at Baker City. The new mill has 10 stamps, with self-feeding arrangement and steam-power. The mine and mill are reported to employ about twenty men. The present superintendent is Mr. D. H. Jackson.

The James Gordon is a promising lode, located last November by Mr. Rockfellow, the discoverer of the Virtue, about seven miles north of the latter mine. At the outcrop the width was 10 inches; at the depth of 35 feet it had already widened to 3½ feet. This was a "blind ledge," and its discovery reflects credit upon the skill of the prospector, whose name and profession combined have earned for him in Eastern Oregon the *sobriquet* of "Old Rocky." Messrs. Rockfellow, Reynolds, and others, who own the mine, will shortly have a lot of 50 tons of the ore tested at the Virtue Mill. Samples sent to me indicate a fine quality of milling rock.

The Golden Gate is a vein of auriferous quartz, discovered last August in the hills one mile southwest of Pocahontas, and owned and worked by Messrs. Bailey & Gray, who have been crushing about half a ton per day with an old-fashioned arrastra. The vein is well defined, and dips about 45°. The product of 22 tons, alleged to be by no means the richest rock, averaged $180 per ton.

In Rye Valley district two new ledges of rich silver-ore have been reported, discovered last fall by Mr. S. B. Franz. The leading quartz-mines of the district are Green's Discovery and the Monumental, both owned by Mr. Charles Green, who reports that he has ore enough in sight to run a 20-stamp mill for one year. Some of the Green's Discovery ore was shipped to San Francisco, where it was sold at $250 per ton. It was said to carry $300 per ton, principally in silver.

The Connor Creek mines are doing well. Messrs. Estabrook, Palmer, and others, the owners, are putting up new machinery, and report an abundance of rich rock.

The placer-mining industry at Eldorado, Mormon Basin, Aurelia, Malheur, Clarksville, and Burnt River has been carried forward about as it was in 1872, and with tolerably satisfactory results. Even Auburn, one of the longest-worked districts, and perhaps the most productive heretofore, is far from exhausted.

The placers along the western edge of Powder River Valley, and at Sparta and Gem, have done about as well as last year. The aggregate shipments of gold-dust from the whole county have somewhat fallen off, though it is not in my power, from a mere comparison of the reports of correspondents from the different districts, to determine what are the precise causes of the decline. There seems to be a general anticipation of prosperous activity in both quartz and placer mining for the future. I venture to prophesy, however, that the effect of the Pacific Railroad will continue to be relatively depressing upon the industry of this part of Oregon, as upon all other mining districts lying just outside of the zone of easy communication with the road—that is to say, the districts along the railroad draw off labor and direct capital from those less favored in this respect. But the undeniable resources of Eastern Oregon will doubtless exert sufficient attraction to overcome this disadvantage in time. Even now that region appears to enjoy a real though retarded progress. Baker City is improving rapidly, a certain sign of the substantial prosperity of the country which supports it.

The following summary of the mining districts of Baker County, from the Oregon Directory of 1873, gives a good notion of the number and extent of active camps:

> Baker County, with its ten thousand square miles of territory, is the wealthiest gold-bearing portion of the State. The first gold was discovered there in 1861, when the population was confined to a very few, but that magic discovery has lured persons there so steadily that it has now a population of nearly four thousand, and property valued at over half a million-dollars—four times that sum would be more exact. The mines extend over the entire area of the county, and all pay largely. A gentleman who is well informed on such matters estimates the gold productions of the county at two million dollars per year, and judging from the number of mines and ditches, this figure would seem rather below than above the actual sum. The mines are generally placer, but quartz has been receiving attention of late, and is found exceedingly remunerative. The principal ledges and mines encircle Baker City, which is the deposit of supplies, owing to its central locality. Within the limits of this city, the Virtue Gold Min-

ing Company have established a 10-stamp steam-mill, for crushing the quartz taken from their celebrated mine, the Rockfellow and Union lode, seven miles distant. This was discovered in 1863, and has been worked ever since; the ledge is two feet and a half wide and has been entered to a depth of 400 feet, yet it pays better than ever, yielding $30 per ton. The mine and mill employ about twenty men. Twenty-five miles southeast from Baker City are the Burnt River mines, which employ about one hundred and fifty men in the mining season. The camp is supplied with water from Burnt River, and with edibles by the farmers in the vicinity, who raise sweet potatoes, tomatoes, fruits, and cereals in abundance.

Rye Valley, one of the oldest camps in the county, has both quartz and placer mines; the gold is of a coarse quality, and valued at from $12 to $16 per ounce. The placer mines extend over a large area, are quite deep, employ two hundred men in season, pay from $10 to $100 per diem, and are worked with water from the ditch leading to Dixie Creek. This ditch is about five miles long, and has a capacity of 600 inches; enough to supply all demand. The quartz is very rich in silver, the yield sometimes amounting to $300 per ton. This sum was derived from a lode called Green's Discovery Lode.

Humboldt Basin is a town and mining camp; the mines, which embrace placer and quartz, are situated in what seems to be an ancient crater, on the summit of Humboldt Mountain. Large nuggets have been found in this camp, and one picked up in 1866 was valued at $640. All the gold is of fine quality and worth from $14 to $18 per ounce. The mining season is short—from March till June—and the only water convenient is that produced by the snow melted by the sun. Were water abundant, these mines would prove very rich, as they yield an average of $20 per diem, though they have been worked since 1862; they give employment to two hundred men including Chinese. A quartz lode found there is well defined and prospects well. The mines are supplied from Baker City, distant thirty-five miles in a northwesterly direction. Five miles southeast of this camp is Amelia City, a town in the midst of a large and wealthy mining district. There are about thirty gulches in this district which pay from $10 to $30 per diem to the hand. Water is plentiful, and is conducted to the mines by a ditch, which is four miles long and cost about $15,000.

Shasta, or Willow Creek mines, are situated in the southwest portion of Mormon Basin, and yield from $5 to $100 per diem to the hand; they are supplied with water from the Alder Creek ditch, which is forty miles long and cost $50,000; and by the great canal of the Malheur and Burnt River Consolidated Ditch and Mining Company, which has a length of one hundred and twenty miles, a capacity of two thousand five hundred inches, and cost a quarter of a million dollars. Besides these, there are two smaller ditches, which have a capacity of one hundred inches, a length of three miles, and cost $8,000. The camp has two towns, El Dorado and Malheur City, which have a population in the season of from two to four hundred each. These mines are supplied with agricultural productions from the Willow Creek Valley, which produces esculents and cereals.

Bridgport, a small town, and the headquarters of the Chicago Ditch Company, is in the midst of a placer country which extends for twenty miles. The ditch there has a capacity of fifteen hundred inches, cost $35,000, and supplies one hundred gulches in its course of thirty-five miles.

Clark's Creek mines, four miles southeast of the former, were discovered in 1862, and have been worked since by from two to five hundred men each season. They yield from $10 to $50 per diem to the man, and are supplied with water from the ditch of Virtue and Buckland, which has a length of ten miles, a capacity of 400 inches, and cost $25,000.

Winter's diggings, Gimletville, and other camps, extend along Burnt River, a distance of forty-five miles up into the Blue Mountains; the mines are in what is called the gravel vein, and pay well. Nuggets valued at from $100 to $500 are found quite often. Water is scarce, and the main dependence is on melted snow; good quartz ledges have been found recently in Umpqua Gulch.

Deer Creek camp, situated on Powder River, twenty miles northwest of Baker City, is worked principally by Chinese, who earn about $3 per diem; water is supplied from a ditch connecting with the river. Auburn mining district was discovered in 1862, and for three years subsequently employed a population of from four to six hundred; it has yielded several million dollars and is still paying well. It is supplied with water from the Auburn Canal, which has a capacity of 2,000 inches, a length of thirty miles, and cost $230,000. The Oro Fino lode in this camp prospects very largely; a tunnel 400 feet long has already been worked, and the more progress made the better does it yield.

Stiles's Gulch, five miles from the preceding, produces coarse gold, some of the nuggets being valued at $100 to $1,000. Owing to the scarcity of water it is but little worked.

Griffin's Gulch, eight miles west from Baker City, is the place where gold was first discovered in the county, in the autumn of 1861. It has yielded largely, but it employs only thirty persons. Washington, Rean, and other gulches have been mined since 1867, and are yet worked to advantage by two hundred persons. A fine quartz lode on

Rean Gulch yields $30 per ton; it is crushed at the Virtue mine at Baker City. The former gulch is owned by Chinese, who earn an average of $5 per day. Salmon Creek mines yield from $5 to $20 per diem to the hand; the quartz ledges there have been worked a little. Water is supplied by three ditches, erected at a cost of $5,000.

Rock Creek mines, twelve miles north of the town of Pocahontas, which are extensive and promise to be lasting, yield from $10 to $50 per diem to the hand during the mining season; water is supplied by the Rock Creek ditch, which has a length of six miles, a capacity of 500 inches, and cost $10,000. Good paying mines have been discovered recently on Conner Creek, forty miles southeast of Baker City, near Snake River. A quartz lode—the Eddleman—is one of the richest in the State; it is two feet and a half wide, and well defined, with good casings. A 10-stamp mill has been erected there, and all reports attest the richness of the rock. This region promises to be one of the best mining camps in the State when it is prospected. There are only a few persons in the district at present, and they do not care to hunt quartz, as long as placer mines can be found. A large area of country has not been prospected in the least, as the old mines are still paying well. From all information that can be gathered, Baker County has only commenced to develop its rich mineral treasures, for though over one-third of the population is now engaged in mining, it may be safely estimated that twice or thrice the number could pursue it with profit. There is more enterprise manifested in the county than in any equal area on the coast, which is apparent from the fact that two hundred and sixty miles of ditches, having a capacity of 7,350 inches, and costing about $648,000, have been built there, and that more are being constructed as rapidly as they are required.

Grain of all kinds is low this winter. There is, however. market for all that is produced.

The climate is very healthy. There are no chills here. Rheumatism and bilious fever are the most prevalent diseases, we believe. There is an abundance of good timber (pine and fir) in this country. There is also plenty of good stone. Lumber is worth from $14 to $18. Good water is obtained by digging from 8 to 14 feet. The society is as good as most of frontier countries. There are churches, and our school advantages cannot be excelled. Mechanics get from $3 to $5 per day. Labor is $40 to $50 per month, gold coin. There are slack times now, but there is generally a plenty of work to do. The country is improving very fast. It costs a little more to live here than east of the Rocky Mountains.

Cattle are very cheap, and horses are lower in price than they have been since the first settlement of the valley. Ponies sell at from $6 to $30. American horses at from $70 to $125. It would cost from $250 to $500 to get a team. Wagons are higher than east of the mountains.

It costs from Omaha to Baker City, via Kelton, Utah, first-class, $150; and second-class, $110. Purchase a through ticket. It would not be advisable to ship anything except bedding, clothing, &c.

CHAPTER V.

UTAH.

In the mining industry of this Territory great energy was everywhere displayed up to the time of the unfortunate financial panic in the East. During the last quarter of the year, however, a great many of the largest mining companies of Utah, and nearly all the smelting-works, either stopped operations entirely or prosecuted them on a very limited scale.

It is noteworthy that during the panic most of the English companies were in the worst straits, and even the Flagstaff, which has been heretofore considered the company resting on the most solid foundations, came into serious financial difficulties.

Smaller mining enterprises, and especially those in which the partners are themselves working miners or citizens of Utah, did not suffer as much as the large stock-companies, though they too were much embarrassed for a time on account of the impossibility of selling ores to smelting-works.

As to the latter, I have to notice the erection during the forepart of the year of a number of new works, most of which are of large capacity, and the enlargement of some of the older works. Among the former are the Chicago Works at Rush Lake, the Shaunty Springs Works in Star district, the Mammoth Copperopolis Copper Works in Tintic, and the Galena, Sheridan Springs, Last Chance, and Mountain Chief Works, near Sandy Station, on the Utah Southern Railroad. Among the latter I mention the American Works, (formerly Robbins's,) enlarged to three times the former capacity, and the Wahsatch Works at Big Cottonwood. Most of those smelting-works situated near the Utah Southern Railroad have been in operation during the greater part of the first three quarters of the year, smelting, some of them, Bingham ores alone, and others Bingham ores mixed with higher grade ores from Little and Big Cottonwood and other districts. The result is a largely-increased product of base bullion during 1873, as will be seen by comparing my statement given below with the one contained in my last report. As to the financial success of the smelting-works, I am sorry to say that very few indeed have been profitable, as was shown by the many attachments on account of debt in the latter part of the year. It must, however, be remembered that this time was an extremely unfavorable one for any business throughout the country. It is, moreover, only too true that the greater part of the Utah works are managed without technical ability, and that fortunes are there lost in slags, dust, and matte which might easily be saved. The Germania refining and separating works form, in this respect, one of the exceptions to the general rule. They have been steadily at work and are a technical as well as a financial success. These works are among the very few in this country where a lead fit for the manufacture of white lead is produced. The works treated during 1873:

	Number tons bullion.	Silver extracted.	Gold extracted.
		oz.	oz.
From Utah	2,430	360,180	1,100
From Nevada, (mostly Eureka)	1,670	200,400	5,610
Total	4,100	560,580	6,710

The following are the stamp-mills and arrastras now in the Territory:

	Horse-power.	How run.	Location.
MILLS.			
Pioneer	25	Steam	East Cañon.
Brevoort	10	Steam	East Cañon.
Enterprise	5	Water	East Cañon.
New Jersey	5	Water	East Cañon.
Wyoming	20	Steam	Tintic.
Miller's	20	Steam	Tintic.
Shoebridge	20	Steam	Tintic.
Copperopolis	25	Steam	Tintic.
Camp Floyd	40	Steam	Lewiston.
ARRASTRAS.			
Pioneer	2	Water	East Cañon.
Baltic	2	Water	East Cañon.
Lower Arrastra	2	Water	East Cañon.

A great deal of prospecting has been carried on in the southern part of the Territory, and several new districts have been organized. With the exception of the discovery of the extraordinary richness of the Mono mine at Dry Cañon, Ophir district, there have been, however, no new developments of great importance.

The iron and coal region in the southwestern part of Utah has received much attention during the year, and a strong eastern company is at work there erecting furnaces for the production of pig-iron, in order to be ready for work when the railroad, which is slowly but steadily extended southward, reaches the fields.

In the direction of dressing-works, which are so essential for a very large part of the Utah ores, an advance, which I hope will be permanent, has been made by the erection of wet-dressing machinery in Bingham Cañon by the Utah Silver-Mining Company, and of a Krom concentrating-works in Salt Lake City. Neither establishment was entirely finished at the end of the year, but both were very near completion. The Emma Company, in Little Cottonwood, has built small dressing-works for the purpose of concentrating the large amount of third-class ore on its dumps. These works have produced between 600 and 1,000 tons of high-grade concentrates; but it has been impossible to get any correct data in regard to the costs or metallurgical losses of the undertaking, the management of the Emma mine having refused all information in regard to the mining or other works of the company. In my opinion it is very doubtful whether, with the class of Utah ore represented by the Emma, dressing will be financially or even technically successful.

The following statement of the product of Utah for 1873 in gold, silver, lead, and copper has been compiled with care from the best attainable authority.

GOLD.

From placers, (express shipments plus 20 per cent. in private hands)	$32, 616 00	
Extracted at Germania Works from Utah bullion, 1,100 ounces	19, 800 00	
Total gold		$52, 426 00

SILVER.

Produced by stamp-mills, 169,486 ounces, at $1.18	$199, 993 48	
Extracted from Utah base bullion, 360,180 ounces	425, 012 40	
Contained in bullion shipped, (8,032 tons)	1, 807, 200 00	
Contained in ores shipped, (12,384 tons).	1, 424, 160 00	
Contained in bullion on hand, (500 tons).	122, 500 00	
	3, 978, 865 88	
Less amount in 1,666½ tons on hand January 1	253, 091 00	
Total silver		3, 725, 774 88

LEAD.

Produced at Germania Works from Utah bullion, 2,430 tons, at 5 cents per pound	$243,000 00	
Contained in bullion shipped, 8,032 tons, at 4 cents per pound	642,560 00	
Contained in lead-ores shipped, 30 per cent. of 11,075 tons, at 2½ cents per pound	166,125 00	
Contained in bullion on hand, 500 tons, at 4 cents per pound	40,000 00	
	1,091,685 00	
Less amount on hand January 1, 1,666½ tons, at 4 cents per pound	133,320 00	
Total lead		958,365 00

COPPER.

In 1,309 tons of ore shipped, 24.6 per cent., at $52.74	$69,036 66	
In 126 tons of black copper, 90 per cent., at $223 per ton	28,098 00	
Total copper		97,134 66
Total product of metals		4,833,700 54
Product of gold and silver		$3,778,200 88

Remarks on the above statement.—The amount of gold product is less than the estimates of Messrs. Valentine, Fabian, and others, who improperly include in the product of the Territory a part or the whole of the gold extracted at the Germania Works from base bullion purchased for those works in Nevada, principally at Eureka. The silver and lead of this Nevada bullion have also been heretofore erroneously added to the Utah production. The Germania Works treated during the year 1,670 tons of Nevada bullion, extracting 200,400 ounces silver and 5,610 ounces gold.

The value of Utah base bullion shipped is estimated at $225 per ton. Mr. Fabian estimates it at $250, which I consider too high, because the amount of low-grade ores treated (containing considerable lead, and hence producing low-grade bullion) was proportionally large during 1873. The Winnemuck and the Flagstaff (and the Davenport for part of the year) were the only works producing high-grade bullion in large quantities. The numerous works along the Utah Southern Railroad smelted chiefly Bingham Cañon lead-ores, producing bullion, a great deal of which did not contain more than 30 to 40 ounces of silver. The value of $225, estimated by me as the general average, includes gold and silver. Judging from the operations of the Germania Works, (2,430 tons of Utah bullion treated; silver, 360,180 ounces; gold, 1,100 ounces,) the value in gold may be 5 per cent. of the value in silver.

The value in gold and silver (mainly silver) of the ores shipped is estimated at $115 per ton, for the reason that of the 12,384 tons shipped, 964 tons from the Mono mine yielded about $442,000, or an average of

$458 per ton; at least 600 tons of Emma dressed ore were worth $500; 1,309 tons of copper-ore carried, at a low estimate, $20 per ton in gold and silver; and 126 tons of black copper, about $80 per ton. This leaves 9,388 tons of unknown value, which can safely, however, be assumed to have contained over 45 ounces of silver per ton, since it would scarcely pay to ship it on a lower basis. The average for all shipments, thus obtained, is $115 per ton.

The bullion on hand and in transit is estimated at 500 tons, against 1,666½ tons at the end of 1872. In that year the Germania Refining Works alone had on hand over 800 tons. The value of the stock on hand having been included in the last report as part of the product of 1872, at a reduced lead-value, to allow for the expense of refining, is now subtracted; while the estimated amount now on hand is added. The silver contents are taken for each year on the basis of the general average for the year.

In reckoning the values of lead, the refined metal is taken at 5 cents; the metal in base bullion ingots, or pigs, at 4 cents, and the metal in ores at 2½ cents per pound.

The values of copper have been calculated at the prices paid in Salt Lake upon the assay. These were, for 24.6 per cent. ores, $59.60 per ton, currency; for 90 per cent. black copper, $252 per ton, currency. I have calculated the prices in gold at 113, thus reducing the values to coin, in harmony with the remainder of the statement of metallic product.

Little Cottonwood district.—As heretofore, this district has maintained its reputation for the production of the highest grade of smelting ores in large quantities. A greater number of mines contributed to the shipments during 1873, than in any previous year. But the Emma, once known as the largest and richest deposit in the district, has fallen off in production very much, and at the end of the year the most active explorations in depth on this property had failed to develop another ore-body of magnitude. From the beginning of the year far into the summer, the lower works of the Emma were much troubled with water, the pumps then in the mine not being of sufficient size to keep the water down. This, I am informed, was afterward remedied. The upper ore-bodies being very nearly worked out, explorations were carried on in depth, as soon as the removal of the water permitted it. During all this time the most contradictory reports in regard to the mine were afloat; and this state of affairs was especially promoted by the circumstance that no visitor was allowed to enter the mine under any circumstances. At the end of the year the common report was that a very large and extremely rich body of ore had been struck in the bottom of the main shaft, which was said to have passed through the limestone and found a wide "vein" of galena, very rich in silver, in the underlying granite, 500 feet from the surface. This rumor obtained much credence in Utah, as well as in London. But finally, in the first week of February, 1874, a circular from the directors of the company denied the truth of the report; and it is now said that the alleged granite in the bottom of the shaft is only brecciated limestone, and that the Emma mine is at this time without any considerable reserves, though it still produces from sixty to seventy-five tons of rich ore per week. During the year the second-class ore from the dumps of the mine has been concentrated by means of jiggers, an ore assaying $1,000 and upward per ton being reported as the product from this operation. The number of tons of concentrated ore produced from the dumps, I have not been able to ascertain, nor the value of the total product. The amount of Emma ore sampled at Mr. Mackintosh's works in Salt Lake City, during 1873, however, is reported to me by the owner of the sampling-works as 7,269 tons. Most of this has been smelted in Utah.

The Flagstaff mine was steadily worked until November, when operations were suspended for a short time, on account of an attachment against the mine by Captain Forbes, one of the managers of the property up to that time, and a strike of the miners, which took place about the same time. This splendid mine has produced during 1873, according to the directors' report, 15,000 tons of ore of an average value of $54 per ton in the ore-market. The same report says the expenses for mining ought to have been $5, hauling $8, establishment-charges $4, total $17, leaving $37 profit per ton. Yet there was not only no profit made, but in the fall the company was very heavily in debt and the value of the shares depreciated rapidly in London. After the stoppage above mentioned, Mr. Patrick was appointed manager.

Although hardly any prospecting work and development in advance took place in the mine during the year, the reserves in sight in the mine in December were estimated by Mr. John Eddy, a Cornish expert, at 6,800 tons. The ore raised from the mine was mostly smelted at the Flagstaff and Last Chance Smelting-Works, but 2,595 tons were sampled at the Pioneer Sampling-Works at Salt Lake City and shipped. According to the latest advice from the mine it was in good condition and about 350 tons of ore were shipped to the smelting-works weekly. The Flagstaff Smelting-Works were lying idle, and the ore was reduced at the Last Chance Works.

The Winsor Company, owning the Last Chance, Hiawatha, Savage, and Montezuma, has worked its mines actively during the year. The ore from these mines is rich in silver and lead, rarely containing, as shipped to the furnaces, less than 50 ounces of silver per ton, and 30 to 35 per cent. of lead. The company sent 1,250 tons of ore to the Pioneer Sampling-Works at Salt Lake City during 1873; 181 tons, assaying from 32 to 43½ ounces of silver per ton and 31 per cent. of lead, were bought by the American Smelting Company.

The Grizzly, situated on Grizzly Flat above Alta City, has shipped 1,200 tons of ore to the sampling-works during the year. It is well opened by shafts and levels, which show an ore-deposit 5 to 6 feet thick. The mineral is rich in lead and silver, and is esteemed by the smelters.

The Vallejo has also been actively worked, 750 tons of ore having been sent to the sampling-works. During the heavy snows in the winter of 1873, when other mines on Emma Hill were seriously interfered with in their regular shipments, this mine was enabled to work uninterruptedly, by the help of the wire tramway spoken of in my last report.

The Oxford and Geneva, a new mine, which has sprung into notice during the year, is situated in the limestone on the left side of Little Cottonwood, on what is called Peruvian Hill, nearly opposite the Flagstaff. The first ore shipped from this mine, a lot of 45 tons, sold to the American Smelting Company, assayed 28.28 ounces of silver per ton, and 32 per cent. of lead. Of 250 tons subsequently sampled at the Pioneer Sampling-Works, the value is not given.

The Toledo has shipped some very rich ore, which is, however, poor in lead, as shown by 125 tons, bought by the American Smelting-Works, which assayed 4 per cent. of lead and 90 ounces of silver per ton.

The Highland Chief has also shipped rich ore, of which 84 tons, containing 53.66 ounces silver and 37 per cent. of lead, were bought by the American Company in August. This may be taken as the average value of the ore shipped from the mine.

The Wellington has had 300 tons of ore sampled at Salt Lake, and various small lots were sold to the furnaces directly. The assays of such lots as came under my observation showed from 52 to 56.5 ounces of silver per ton and 28 to 34 per cent. of lead.

The Revolution and McKay have shipped about 50 tons of very rich ore, assaying 200 ounces of silver per ton and 15 per cent. of lead. The McKay is opened by an incline 30 feet deep and by 75 feet of drifting. The ore-vein is from 3 to 5 feet thick.

The Davenport Company, like nearly all the other English companies in Utah, experienced great financial difficulties in the fall. Its mines, the Davenport and Matilda, are situated on the dividing ridge between Big and Little Cottonwood Cañons, about a mile east of the Emma. Both mines were continuously worked up to the time of the financial panic in the East. The developments on the Davenport consist of several inclined shafts and drifts, and a tunnel 600 feet long. Through the latter nearly all the ore has been transported to a platform, whence it is sent down for 700 feet on a tramway toward the valley. From here to the furnaces, ten miles distant, at the mouth of Little Cottonwood Cañon, it is hauled by wagons. The deposit of ore in the Davenport has averaged so far about 5 feet in width. It is very ferruginous, and rarely contains less than sixty or seventy ounces of silver to the ton, but only twelve to eighteen per cent. of lead.

The Matilda deposit is connected with that of the Davenport; but while the latter has an inclined position, the ore in the former stands nearly vertical. Its width is very variable, and has changed from 4 to 20 feet. Both locations are covered by United States patent. In May, 1873, a new manager, Mr. Philpotts, was sent out from London. On his arrival he found the company's affairs in a very unsatisfactory state. It was in debt in Utah to the amount of $75,000, on which it had to pay a very high interest. About 1,000 tons of ore were then in sight in the two mines. During Mr. Philpotts's brief management he succeeded in reducing the debts of the company to $40,000. At that time 765 tons of ore were stored up at the furnaces, and 200 tons at the mine. Mr. George J. Johnson, a graduate of the Freiberg School of Mines, and the owner of one of the sampling works at Salt Lake City, then took charge, and employed Mr. Weberling, a well-known metallurgist of the West, as manager of his smelting-works. Mr. Johnson at once saw that the ores of the Davenport could not be smelted without great loss, on account of the small percentage of lead contained in them. He tried, therefore, to purchase ores rich in lead, in order to mix them with those from the Davenport; but before he could finish his first campaign, the panic broke out in the East, and the creditors of the company demanded the money due them. As none had been earned yet, and no help was forthcoming from England, the result was that the works and ores of the company were attached, and the latter were sold under the sheriff's hammer at extremely low prices. The latest information I have received in regard to the affairs of the company, is that the Davenport Company intends to re-organize in London and to furnish £15,000 of new capital. This, together with the ore and bullion yet on hand, is thought to be sufficient to overcome all difficulties.

The Victoria and Imperial Tunnel Company was incorporated in 1872, the Alice, Excelsior, Imperial, and Amy May mines being consolidated with that company. This tunnel is located on the Emma Hill, and runs in a length of 640 feet, for the purpose of tapping the above-named mines. At a distance of 482 feet from the mouth of the tunnel a vein was struck, averaging 5 feet of paying ore. The depth perpendicularly from surface at this point is 277 feet. Eighty feet beyond this the tunnel crosses a vein of about 4 inches. The assay value of ore in this vein was $777. According to the last surveys made on the property, the tunnel at 120 feet will cut the main vein. Considerable prospecting has been done on claims above; shafts to the depth of from 30 to 130 feet have been sunk, all showing more or less of fine ore. About 70 tons of ore were shipped from this mine, January 26, 1874, this being the first shipment made. This tunnel, if continued, will not only tap the Alice, Excelsior, Imperial, and Amy May, but also the Davenport mine.

There are a number of other tunnel-locations in Little Cottonwood, among which may be mentioned the Howland, Ætna, and Esther. These three have been worked more or less during the year.

The following is a list of the more important locations in Little Cottonwood Cañon, as published in the London Mining Journal, by Mr. Froiseth, of Salt Lake City:

Name of lode.	Date of record.	Name of locator.	No. of feet.
Monitor and Magnet	Aug. 20, 1868	W. S. Woodhull et al.	2,200
Johanna	Oct. 16, 1868	William Keies et al	2,600
Western Star	Oct. 23, 1868	Titus Axen et al	2,000
South Star	Oct. 20, 1868	Alex. Talbot et al	1,600
Chicago	July 9, 1869	G. L. Howard	1,600
Cincinnati	July 16, 1869	James Smith	1,800
Illinois Tunnel	July 16, 1869	James Smith	.....
Caledonia	July 25, 1869	Henry Anderson	1,000
Diamond	Aug. 20, 1869	G. L. Howard	1,200
Morning Star	Oct. 6, 1869	Titus Axen	3,000
Lavinia	Nov. 11, 1869	N. Groesbeck	1,800
Emma	Feb. 25, 1870	J. F. Woodman	2,400
Creek	Mar. 2, 1870	R. H. Robertson	2,000
Powerful	Mar. 2, 1870	R. H. Robertson	2,000
Silver	Mar. 2, 1870	R. H. Robertson	2,000
Copper	Mar. 2, 1870	R. H. Robertson	2,000
Galena	Mar. 2, 1870	R. H. Robertson	2,000
Pauline	Mar. 2, 1870	R. H. Robertson	2,000
Colfax	Mar. 19, 1870	John Snyder	3,000
Flagstaff	Mar. 19, 1870	Joseph L. Wing	2,200
Grizzly	Apr. 7, 1870	O. P. Rockwell et al	3,000
Gladiator Tunnel	Apr. 18, 1870	W. S. Woodhull	.....
Prince of Wales	Apr. 28, 1870	Richard Gill	1,000
Brain	Apr. 22, 1870	Richard Gill	1,000
Jenny Lind	Apr. 28, 1870	Richard Gill	1,000
California	Apr. 28, 1870	Richard Gill	1,000
Kate Hayes	Apr. 28, 1870	Richard Gill	1,000
Habana	Apr. 28, 1870	Richard Gill	1,000
Paris	Apr. 28, 1870	Richard Gill	1,000
Webster	Apr. 28, 1870	Richard Gill	1,000
Fillmore	Apr. 28, 1870	Richard Gill	1,000
Mary Ann	Apr. 28, 1870	Richard Gill	1,000
Stockton	Apr. 28, 1870	Richard Gill	1,000
Burlington	Apr. 28, 1870	Richard Gill	1,000
White Cloud	May 9, 1870	J. W. Elliott et al	1,200
Idaho	May 28, 1870	J. W. Wilson	1,200
Home Ticket	May 27, 1870	G. L. Howard	3,000
Revolution	June 13, 1870	J. P. Harlow	3,000
Darlington	June 20, 1870	John Shay et al	1,400
Montezuma	June 21, 1870	John Shay et al	1,400
Robert Emmet	June 22, 1870	R. E. Ireland	1,000
Gopher	June 27, 1870	A. J. Despain	3,000
Lillawah	June 14, 1870	Levi North	3,000
Hiawatha	June 14, 1870	A. J. Despain	3,000
Stoker	June 23, 1870	J. Stoker	1,200
Davenport	June 17, 1870	Tim Sullivan	1,800
Rock Island	June 28, 1870	J. W. Elliott	1,200
Ranter	June 20, 1870	J. Richardson	1,000
City Rock	June 29, 1870	Swan Johnson	1,000
Utah	June 20, 1870	James Montgomery	1,000
Sheridan	July 8, 1870	Byron Groo et al	2,000
Wellington	July 19, 1870	Thos. Butterwood et al	1,000
Regulator	July 10, 1870	J. Johnson	1,400
Savage	July 27, 1870	F. Chorpending	1,400
Excelsior	Aug. 23, 1870	J. M. Orr	800
Uncle Sam	Aug. 10, 1870	M. H. Vincent	1,600
Elephant	Sept. 12, 1870	James Larsen	1,000

Name of lode.	Date of record.	Name of locator.	No. of feet.
Vanderbilt	Aug. 10, 1870	B. F. Dewey	1,400
Relief	Oct. 11, 1870	L. V. Winans	1,000
Crown Prince	Oct. 12, 1870	M. K. Harkness	1,600
Frederic	Oct. 12, 1870	M. K. Harkness	1,600
Daisy	July 10, 1870	J. H. Nounnan	1,000
Pocahontas	Oct. 14, 1870	B. F. Dewey	1,400
Lofty	Oct. 24, 1870	M. Davis	2,000
Fanny Wetzel	June 20, 1870	W. K. Rice	1,400
Cheyenne	Nov. 4, 1870	W. H Harlow	1,600
Cedar	May 10, 1870	Josephine Snyder	1,200
German	Apr. 29, 1871	Charles Nack	1,200
Cumberland	May 22, 1871	Mike Welsh	1,000
Boatman	May 20, 1871	N. C. Boatman	1,000
Fuller	June 2, 1871	F. F. Fuller	1,200
Utah Tunnel	June 7, 1871	L. Seaman	......
Ranter, No. 2	June 15, 1871	Thomas Keams	800
Highland Chief	June 15, 1871	Robert Ellis	1,400
Baltic	May 24, 1871	B. F. Dewey	1,200
Green Mountain	June 16, 1871	B. F. Dewey	1,400
American Girl	May 17, 1871	Mike Lynch	1,400
Wallace Tunnel	June 21, 1871	William Wallace	......
Emily	June 22, 1871	D. W. Rench	1,000
New York	June 15, 1871	H. J. Tadder et al	800
Matilda	July 3, 1871	James Larsen	1,000
Oxford	July 7, 1871	H. J. Tadder et al	800
Phœnix Tunnel	July 7, 1871	R. E. Thompson	......
Surveyor	July 19, 1871	T. B. Orny	1,400
Fiorinda	June 21, 1871	J. M'Culloch	1,400
Last Chance, No. 2	July 22, 1871	H. Harvey	600
Conquerer	Aug. 11, 1871	J. A. Varnes	1,200
Detroit	Aug. 20, 1871	J. Speer	1,200
Adelaide	Aug. 26, 1871	B. F. Dewey	1,000
Rexford	June 24, 1871	W. A. Rexford	1,200
Thomas Jefferson	Sept. 8, 1871	William McKean	1,200
Silver Shield	Sept. 9, 1871	J. Johnson	600
Victoria Tunnel	Sept. 4, 1871	S. A. Coburn	......
Jones and Paddock	Sept. 1, 1871	T. A. Jones	1,400
Owen and Gardner	Sept. 17, 1871	Henry Owen	1,400
Wells Fargo Tunnel	Sept. 20, 1871	F. Priest	......
No. 1 Tunnel	Sept. 1, 1871	Alex. Majors	......
Toledo	Oct. 1, 1871	J. M. Haskell	1,200
Ida	June 21, 1871	William Moore	1,200
First National	Oct. 26, 1871	T. B. Orny	1,000
Durango	Oct. 28, 1871	J. A. Varnes	1,400
Lexington	Oct. 31, 1871	G. P. Dow et al	3,000
Cashier	Nov. 10, 1871	T. B. Orny	1,000
Manhattan Tunnel	Nov. 12, 1871	J. C. Parker	......
Equitable Tunnel	Dec. 5, 1871	R. E. Thompson	......
Keystone Tunnel	Dec. 20, 1871	G. L. Howard	......
Little Giant	July 20, 1871	C. H. Fry	1,000
Fredonia	Dec. 26, 1871	G. W. Arnett	1,400
Howland Tunnel	Mar. 25, 1872	W. H. Howland et al	......
Etna Tunnel	Mar. 25, 1872	W. H. Howland et al	......
Royal George	Mar. 27, 1872	J. Donahoe	1,200
Wahsatch Tunnel	Apr. 23, 1872	W. H. Howland et al	......
Wyoming	Apr. 25, 1872	James Wall et al	2,000
Silver Vault Tunnel	May 7, 1872	J. M. Harker et al	......
Lady Emma Tunnel	May 7, 1872	J. C. Parker et al	......
Lady Esten Tunnel	May 9, 1872	C. J. Collins et al	......
Brewer and Lapham Tunnel	May 13, 1872	W. M. Brewer et al	......
Bay City Tunnel	May 25, 1872	W. H. Ashton et al	......
Pacific Tunnel	May 25, 1872	W. H. Ashton et al	......
Fillmore Tunnel	May 23, 1872	A. M. Doughman et al	......
Challenge	June 3, 1872	L. U. Colbath	1,500
Sacramento Tunnel	June 3, 1872	J. A. Varnes	......
Black Mountain	June 6, 1872	D. F. Richards	1,200
Tobas Tunnel	June 5, 1872	J. M. Haskell	......
Lady Moorhead	June 17, 1872	J. W. Brewer	1,500
Haskell	June 19, 1872	J. M. Haskell	1,500
Rollins	June 24, 1872	C. C. Bradshaw	1,500
Royal Tunnel	July 8, 1872	C. C. Morse	......
Hermann Tunnel	July 14, 1872	F. W. Hermann	......
Amador	July 9, 1872	J. N. Hayes	1,500
Hero	July 18, 1872	H. Peiroe	1,500
Maxwell Tunnel	July 26, 1872	N. M. Maxwell	......
Oxford and Geneva Tunnel	Aug. 8, 1872	J. B. Scott	......
Wild Irishman Tunnel	Aug. 23, 1872	M. Kelly	......
Board of Trade Tunnel	Aug. 19, 1872	J. A. Varnes	......
Jacob Astor Tunnel	Aug. 27, 1872	S. M. Dinghman	......
West Point Tunnel	Sept. 7, 1872	D. C. McGlynn	......
Topeka Lode	Sept. 27, 1872	L. V. Winans	1.500
Henderson Tunnel	Sept. 27, 1872	J. M. Henderson	......
Trojan Lode	Oct. 7, 1872	J. J. Burnside	1,500

Name of lode.	Date of record.	Name of locator.	No. of feet.
Rockford	June 1, 1872	J. W. Whitfeet	1,500
Windsor Tunnel	Oct. 12, 1872	J. L. Hathaway	......
Flora Temple Tunnel	Dec. 3, 1872	S. M. Dinghman	......
Rappahannock Tunnel	Dec. 13, 1872	T. B. Orny	......
Occident Lode	Sept. 21, 1872	L. Maptes	1,500
Mobilier	Oct. 9, 1872	A. J. Fitzgerald	1,500
Cunard	Oct. 12, 1872	L. Maptes	1,500
Belmont	Oct. 12, 1872	L. Maptes	1,500
Merchant	Oct. 31, 1872	J. E. Winzle	1,500
Comstock	Dec. 18, 1872	J. E. Winzle	1,500
Othello	Apr. 7, 1873	L. M. Dinghman	1,500

The following is a statement of the amount of ore sampled at the Pioneer Sampling Mill, Salt Lake City, for the year 1873, from mines in Little and Big Cottonwood Cañon:

Name of mine.	Tons.
Emma	7,269
Flagstaff	2,595
Grizzly	1,200
Davenport	600
Vallejo	750
Prince of Wales	650
Winsor	1,250
Western Star	30
Oxford and Geneva	250
Mackay	50
Revolution	8
Wellington	300
Total	14,952

In *Big Cottonwood district* the Reed and Benson, Highland Chief, Wellington, Prince of Wales, and Richmond are the most prominent mines, as far as developments and yield during the year are concerned.

The Reed and Benson, its location, mode of occurrence, and the connection of its works with the valley below by means of a splendid tramway 1,600 feet long, was described in my last report. I have only to add here that developments have been pushed actively during 1873, and that some of the richest ore of the Wahsatch Mountains has been raised from this mine. Important discoveries of rich ore in quantity were, however, made so late in the season that but little ore was taken out from the new bodies. The ore shipped by the mine during the year has principally been smelted by the American and Wahsatch Smelting Works. It is a very ferruginous ore, containing about 25 per cent. of lead and over 50 ounces in silver. The mine is now sunk upon to a depth of 600 feet, and there is a tunnel on it 500 feet long.

The developments in the Highland Chief and Wellington are materially aided by the employment of the Ingersoll drill. The rock met with in the tunnel is a very siliceous limestone, but 4 running feet are nevertheless excavated every twenty-four hours. Both mines have shipped ore during the year; that from the Wellington containing about 22 per cent. of lead and 33 ounces of silver per ton, while that from the Highland Chief is much richer, assaying 34 per cent. of lead and 95 ounces of silver per ton. In the same mineral-bearing zone as the above mines lie the Homeward Bound, Sailor Boy, (on Kessler's Peak,) McDonald, Montreal, &c.

On the North Fork of Big Cottonwood Cañon is situated the Dolly Varden, developed by an incline 200 feet deep. It shows a large deposit of low-grade ore, several hundred tons of which, assaying about $25 per ton, have been shipped. It is a good smelting-ore. The Mayfield, Adelaide, York, Patchen, and several others are in this vicinity.

In Honey-Comb Fork are situated the Prince of Wales and Richmond. The first is opend by two tunnels and a shaft. One of the tunnels is 320 and the other 900 feet long. About thirty men have been employed at the mine during a large part of the year and considerable ore has been shipped.

The Richmond is opened by a shaft and a tunnel, the latter striking the ore-deposit at a depth of 190 feet. The vein is about 4 feet wide, and contains carbonate of lead which assays high in silver, much of it containing over $100 per ton.

From the Sailor Jack, which is opened by two tunnels, respectively 140 and 100 feet long, and a shaft sunk from the floor of the last-named tunnel to a depth of 130 feet, about 140 tons of ore have been shipped.

West Mountain district, in Bingham Cañon, has furnished during last year by far the greater part of ore for the numerous smelting-works in the vicinity of Sandy and along the Jordan. During the latter part of the fall the narrow-gauge railroad, connecting Bingham with Sandy station on the Utah Southern Railroad, was finished up to the Winnemuck company's smelting-works, thus furnishing cheap transportation for the immense masses of low-grade lead-ores. These ore-deposits occur either in quartzite, or as contact-deposits between limestone and quartzite. The latter carry low-grade ore, while the former contain more silver and less lead.

All along the main Bingham Cañon, and especially in that branch of it called Bear Gulch, are found gold-placers. They are mostly on the hill sides, and, in some instances, apparently on old river channels. In the main cañon they have been worked for the last five years, and have generally paid well. During last year most of the gold was taken out in Bear Gulch. Usually the placers can only be worked in the spring, when the melting snows furnish a sufficiency of water. In the summer and fall only the placer-claims located in the lower part of the main cañon, which are opened by shafts and drifts on the bed-rock, can be worked. The product of all the placer-claims in the cañon during the last year is reported as about $27,000 only, being a large decrease from last year's yield.

A very large number of deposits of low grade lead-ores have been opened and worked in the district during the year. Of these the Spanish, West Jordan, Jordan and Galena, Neptune, Kempton, and Yosemite have shipped the most ore.

The Spanish is located high up in the cañon, opposite the Utah and Galena mines, on Silver Hill. The controlling interest in this mine is now owned in New York. The deposit is reached by means of several tunnels, and opened by drifts and two inclines from the floors of the drifts. A large but very irregular body of ore has been exposed, which appears to lie parallel to the slope of the hill. The greater part of the ore is a mixture of carbonate and sulphate (perhaps of anglesite and leadhillite, or cerussite) of lead; but in one of the inclines a layer of galena from 1 to 5 feet thick was found. All the ore contains very little silver, rarely over 12 to 15 ounces to the ton, but is very rich in lead—so rich, in fact, that the owners contract with smelting-works to furnish large quantities of ore containing not less than 45 per cent. of lead. The total yield of the mine during 1873 was 4,765 tons, the greater part of which was smelted at the Wahsatch Works at Big Cottonwood, on the Utah Southern Railroad. The American Smelting Company worked the next largest amount. At the end of the year the lowest tunnel, which was started from a point only a few feet above the level of the creek, had reached the deposit, and levels run from it had developed the continuation of the oxidized ores above.

According to a careful analysis made by Mr. James T. Blanchard, mining engineer, of Salt Lake City, the ore of the Spanish mine contains the following constituents: (I abstain from publishing the full analysis, which is the private property of Mr. Blanchard:)

$Pb\,Cl$	0.41
$Pb\,O_1\,S\,O_3$	61.40
$Pb\,O_1\,C\,O_2$	12.92
$Pb\,S$	9.04
Total lead by analysis, per cent	64.93
Total lead by fire assay, per cent	55.70
Total silver, per ton, ounces	14.76
Total gold, per ton, ounces	0.07

The West Jordan, on Jordan Hill, has been opened to a depth of 200 feet. The horizontal workings are over 800 feet in length. The mine shipped ore during the greater part of the year, and at the end of the year had reached an output of from 30 to 50 tons per day, the ore assaying from eight to fifteen ounces in silver, and forty-five to fifty per cent. of lead.

The Jordan and Galena is also located on Jordan Hill, close to the mine just mentioned. These mines are now owned by Carson and Buzzo, who bought them during the year, in order to have a regular supply for their smelting-works at West Jordan, a small settlement on the banks of the Jordan River, near where the Bingham Cañon Railroad crosses the stream. The location is 7,400 feet long by 140 feet in width. It contains the largest deposit of low-grade lead-ore at present known in Utah. The ore came up very near to the surface, and most of it has been taken out from an open cut. The deposit has been exposed by the removal of a thin layer of earth for a distance of 1,000 feet. Underground the developments of the mines consist of 3,400 feet of tunneling, 700 feet of shafting, and about 800 feet of cross-cutting. The ore is of lower grade even than that of the other large Bingham mines, the contents varying from eight to sixteen ounces of silver in the ore, as it is shipped to the smelters. About thirty men have been employed at the mine during most of the year, and the monthly outlay was generally about $3,000. In the fall, a body of somewhat richer ore was found in the 40-foot level, starting from the open cut. This deposit is reported to be 11 feet thick.

From a late report of Prof. J. E. Clayton on the West Jordan and Jordan and Galena mines, I insert the following extract. It will give a good idea of the situation, mode of occurrence, and value of the ore deposit:

> The Galena and West Jordan mines are situated on the north side of Bingham Cañon, near its head, at the east base of the central ridge of the Oquirrh, or West Mountain range. Bingham Cañon and its numerous branches have cut deep gorges into the mountain side, thus forming high lateral spurs and ridges between the various branches of the stream.
>
> The Galena and West Jordan lodes are really parts or branches of one great lode, that cuts the country rock obliquely, both to the line of strike and dip of the beds. The general course of the lode is nearly northeast and southwest, but is not the same throughout its length. At the eastern end of the lode, from the Utah Company's

works to the discovery shaft in the center of the Galena location, the course is nearly east and west, magnetic, and the dip about 50° north. The upper portion of the lode has evidently been pressed down hill toward the cañon, and we may expect to find the lode nearly vertical in depth. From the initial point of location, going toward the main ridge of the mountain, the lode curves to the southwest and cuts through the beds of dolomite and quartzite obliquely. The dolomite beds west of the lode have a course east and west, and dip 30° to 50° north. The width of the vein varies greatly at different points along the outcrop. Commencing at the east end of the explorations, near the Utah Company's furnaces, and running westerly for a distance of seven or eight hundred feet, the lode will average over 20 feet wide, measured at right angles to its walls. Surface explorations have been made the entire length above named, by stripping off the loose soil and *débris*, and there are numerous cross-cuts across the outcrop, as well as a number of shafts and pits, sunk to depths varying from 6 feet to 100 feet deep.

The ore in the Galena lode at the surface, and to a depth varying from 50 to 100 feet, is mainly a soft gray carbonate of lead, with occasional bunches and streaks of galena. Some portions of the ore-body are highly ferruginous, especially near the walls, and occasionally stains of copper in the form of carbonate and silicate are met with. There is but little gangue stone or waste matter in the ore-body; now and then bunches of spongy quartz of small extent are found, and some clay seams and earthy infiltrations, but nothing that can be called a true gangue stone. The ore occurs as a carbonate of lead above, and as galena, or sulphide of lead below the permanent water-line. The ore-body exposed by the explorations, and composed mainly of clear carbonate of lead, easily reduced in the blast-furnace, can be safely estimated as 700 feet long by 20 feet wide and 60 feet deep, making 840,000 cubic feet. Counting 12 cubic feet to the ton of 2,000 pounds, we have 70,000 tons of ore in sight in this portion of the Galena lode.

The West Jordan lode unites with the Galena lode at a point about 100 feet west of the old Jordan shaft, which is a little south of the center stake of the Galena location. From the point of intersection the West Jordan runs nearly east magnetic to the Utah Smelting Works, a distance of about 1,000 feet. The two lodes, or the two main branches of the one great lode, diverge rapidly, going east for a distance of perhaps 300 feet, at which point they are about 100 feet apart. Thence going east, the two lodes are nearly parallel in course as far as they are traced into the ground now being worked by the English company, (Utah Lead and Silver Mining Company, limited.)

The ground between these two main branches of the vein is also cut and fissured in various directions by veins of ore varying in width from a few inches to 6 or 8 feet, all connecting at various angles with the two main branches. The lower, or West Jordan branch of the lode, varies in width from 4 to 10 or 12 feet, in a distance of over 1,000 feet in length. Being south of the Galena lode and much nearer the cañon, the water-line is nearer the surface. Hence the carbonate ore does not extend to the same depth as in the Galena mine. The ore in sight in the West Jordan, and the interlacing branches between it and the Galena, can be safely estimated at 25,000 to 30,000 tons, making a grand total of about 100,000 tons of ore above the water-line, or an average depth of about 60 feet. We cannot expect such enormous bodies of ore to be rich in the precious metals. The ore is, in fact, low grade in silver and gold, the average not exceeding $15 to $20 in gold and silver to the ton of ore, in that portion of the mine now being worked, (eastern portion.) In the western portion of the ground explored, the ore carries from $20 to $30 per ton in silver and gold.

The ore will average about fifty per cent. in lead, and it takes about 2¼ tons of ore to produce one ton of lead-bars.

The greater part of the ore has been smelted at the Galena works, but much of it has also been shipped to other smelters in the vicinity, and to Chicago. The smelting-works at West Jordan, belonging to the parties mentioned above, consist of three shaft furnaces, two of which are the cupola furnaces, known as Mackenzie's, which in the East are much used for the melting of pig-iron in founderies. The Mackenzie furnaces, as was to have been expected, caused much trouble in smelting the earthy lead-ores. It is now intended to remodel the works by building four reverberatory furnaces and six common shaft furnaces, such as are used for lead-smelting. The building for these new works and two of the reverberatory furnaces were commenced in the fall. The reverberatories are intended for the roasting and slagging of the ore. They are connected, by means of arched flues, with a smoke-stack 63 feet high. The flues are 150 feet long. The reverberatories stand on a terrace on a level with the charging doors of the shaft furnaces. They are said to be constructed according to the plans of Mr. A. Wartenweiler, the fireplaces being virtually gas generators and the fire-bridge being hollow and perforated with holes on the top, through which the warmed air necessary for the combustion of the gases is introduced. The bullion made at these works has rarely contained more than $50 in silver per ton.

The Neptune is also located on Jordan Hill, and is developed by three inclines, 120, 180, and 180 feet deep, respectively. The first two are connected by a drift 60 feet long and the last two by one 20 feet long. There are 600 feet of levels run in the mine. The ore deposited is from 4 to 12 feet wide and lies between quartzite on the hanging and limestone on the foot wall. The mine has altogether furnished about 2,000 tons of ore, 400 of which were sampled last year at the works of R. Mackintosh, of Salt Lake.

The Kempton is developed by an incline 175 feet deep and by 250 feet of levels. The deposit is very similar to that of the Neptune. About 1,200 tons of ore have been taken out, 650 of which were sampled at Salt Lake during the year.

On the Yosemite an incline 200 feet deep has been sunk. A drift run from the bottom along the strike of the ore-body for 40 feet shows 6 feet of ore. At a depth of 100 feet from the surface there is another drift 30 feet long. There is another incline on the mine, and a drift is run out from it. The ore-body shows a thickness of from 4 to 5 feet. It is poor in silver and rich in lead, like the ore in all the other mines in this vicinity.

On the Vespasian a large body of ore has been found in a tunnel, which is run into the hill from the bottom of the gulch, a distance of 450 feet. This ore contains about $30 in silver to the ton and 15 per cent. of lead. About $14,000 have been expended on the claim.

The Nez Percé, situated in Bear Gulch, has a shaft about 80 feet deep, disclosing a 4-foot vein. The ore contains above 40 per cent. of lead and 10 to 20 ounces of silver per ton. The mine has shipped for a time from 10 to 15 tons of ore per day.

The Utah Silver Mining and Smelting Company has raised new capital and followed, in the working of its property, an entirely new plan. Having found in the lower works of the mines large bodies of galena and iron pyrites, which by means of the splendid hoisting-works can be cheaply extracted, the manager now intends to dress these ores principally by jiggers, and then to sell the concentrated product to smelting-works. The experiments so far made on a small scale show that the quartz gangue can be removed easily enough, and that the separation of the iron pyrites and galena is perfect; but at the same time it was found that the loss of silver in concentration was very great. While the lead can be concentrated from 80 to 20 tons, the contents of silver increase only from 12 to 16 ounces per ton. Still it is thought that it will be cheaper to dress and lose the silver than to smelt at once the raw product of the mine. At the end of the year the company had nearly completed its dressing-works, but was again in financial difficulties, so that the enterprise came to a stand-still for want of funds. Very little ore has been shipped from the mine during the year. The smelting-furnaces of the company have been torn down.

The Last Chance, which is mentioned in my last year's report as having been sold to an English company, has been worked during the greater part of the year. The vein is narrow, but contains siliceous ore of far higher grade than the rest of the Bingham mines. A good deal of ore was extracted and shipped during the year to the company's smelting-works at Sandy, where it was treated, together with Flagstaff ore from Little Cottonwood, which supplied the necessary flux for the quartz. At the end of the year the lower works of the mine were under water, and the company, having got into difficulties, shut down for the winter.

The Winnamuck mine has been worked throughout the year. It is developed now as follows: by the upper tunnel, 350 feet long; the windlass tunnel, 500 feet long; the Bushnell tunnel, 400 feet; the lower tunnel, 600 feet long. The main shaft is 130 feet deep. The different levels, drifts, winzes, &c., aggregate 5,000 feet. The mine and the smelting-works connected with it are now owned by an English-Dutch company, and are reported to have produced $876,000 during 1873. Both furnaces were in blast during about half the year; during the remainder only one was running. The Winnamuck works are among the very few where the matte produced with the lead during the smelting is saved.

The Saturn mine has not been worked during the year, but the smelting-works of the company at Sandy were doing custom work up to the time of the financial panic, when they were attached for debt, and remained closed during the rest of the year.

There are a great many mines besides those above mentioned, in Bingham Cañon, and its branches; but none of them have so far shipped large quantities of ore.

Ophir district.—Though the older mines in this district, which were mentioned at length in my former reports, have yielded ore in fair quantities and generally of good quality during last year, they have been far surpassed in value of yield by the Mono mine in Dry Cañon, the high excellence of which had just been ascertained at the time when I made my last report. The Mono is a contact-deposit between limestone and slate, discovered by following a narrow seam of ore in the limestone on an incline of about 28° for about 400 feet. Here the slates were reached and the seam opened out at once into a chamber, which contained ore of extraordinary richness. The deposit was explored in depth by shafts and levels, which showed that it was extremely irregular, but always rich. In the lowest workings the "vein" is reported more regular than above. Some of the ore is so rich that a single car-load of it brought $55,000.

The following data in regard to the shipments of the mine were kindly furnished me by Mr. G. J. Johnson, of Salt Lake City:

4 tons sold in Salt Lake City at $5,000 per 2,000 pounds	$20,000
About 40 tons sold to San Francisco	100,000
920 tons, assaying on an average $350 per ton	322,000
	442,000

Mr. Johnson says, in his letter accompanying the above, that the amounts are not absolutely accurate, as the owners of the mine did not fulfill their promise of furnishing the authentic information, but that he is confident of their essential correctness. As Mr. Johnson has himself sampled by far the greater portion of the ore shipped from the Mono, his estimate is undoubtedly very near the truth.

On the same hill as the Mono, but about 200 feet lower, is a second stratum of limestone, in which also rich ores occur. Still lower, in a third limestone layer, occur deposits of smelting-ore. Among these claims are the Baltic, Fourth of July, Hidden Treasure, Sacramento, Antelope, and Buckhorn, each of which has produced more or less ore. The Hidden Treasure has, however, furnished the most, (600 tons.) The ore from this mine contains from 40 to 75 per cent. of lead, and about 35 ounces of silver, per ton. On the foot-wall of this mine occur copper-ores.

Below the Hidden Treasure and parallel to it lies the Chicago mine, which according to all accounts has been very successful during the year. Professor Clayton says, in his manuscript report on this mine:

> The geological structure of the mountains is limestone, interstratified with occasional bands of shale and quartzite. The Chicago occurs in a belt of limestone, several hundred feet thick, in which the lines of stratification are distinctly marked, the strata varying in thickness from a few inches to several feet. About 200 feet northeast of the outcrop of the Chicago lode, higher up the hill, the lime-beds are overlain by heavy beds of calcareous shales. On the contact of these two rocks the Hidden Treasure mine is located. The Chicago ore deposit, 200 feet below, is conformable in strike and dip to the limestone strata, which is east and west for the former and north for the latter. The deposit may be designated as a "bed-vein." It must, however, be remarked, that the ore does not occur as a bed or sheet of uniform thickness, but in a series of pipes or chimneys, located at irregular distances along the line of outcrop. Between these pipes of ore, the vein is pinched to a seam of small dimensions. In the line of the dip the pipes appear to be continuous. The shape varies, however, considerably. In the upper part of the main incline, the ore-body was from 3 to 4 feet thick, but lower down it expanded into large chambers, which are from 10 to 20 feet wide. In addition to this ore-deposit on the line of stratification there are two systems of cross-fissures, cutting the lime-beds. First, there are nearly vertical fissures, having a north and south course, crossing the direction of the main ore-bed. Second, fissures having a course northwest and southeast, and a slight dip to the southwest. It is seen that there is thus a regular net-work of fissures in existence here. The large ore-chambers appear to occur at those points where the two systems of fissures intersect the "bed-vein." The main incline (No. 1) has been sunk to a depth of 250 feet. At this point a cross-fissure was encountered, which ran into a large chimney of ore. The strike of the fissure is northwest and southeast, and its dip southwest at an angle of about 75°. The pitch of the ore-chimney is northwest, at an angle of about 45°. From the bottom of the incline, drifts have been run to the right and left in this ore-body. The one to the right has a total length of 50 feet; that on the left is 45 feet long, and both are entirely in ore. The ore-body is also explored for 20 feet in height. In the southeast or right-hand drift the ore-body contracts to a thickness of 5 or 6 feet, but in the northwest drift it expands into a large chamber, the width of which is not yet known. A carefully-prepared average sample of the ore occurring here assayed 51 per cent. of lead and 37.9 ounces of silver per ton. The ore is mostly carbonate, but bunches and streaks of galena are frequently found in the mass. The Rambler incline is 70 feet deep. The vein shows here more the character of a "bed-vein" than in any of the other openings. In the first 50 feet of the incline the ore is considerably mixed with calcareous shale, but in the remaining portion of the shaft the ore is free from lime, and consists almost entirely of a highly ferruginous carbonate of lead. The deposit is from 3 to 4 feet thick. An average sample taken from this incline contained 40 per cent. of lead, and 46 ounces of silver per ton. One hundred and sixty-five tons of ore from the Chicago mine have been reduced, in the latter part of 1872, in the smelting-works of Jacobs & Co., at Stockton. The average assay value of this ore was 43.6 per cent. of lead, and 29.6 ounces of silver per ton. About 600 tons of ore are on the dumps ready for shipment.

This was written in February, 1873. Besides the openings above mentioned, there were two more inclines on the deposit. Shortly after the mine was sold to an English company, and explorations were actively carried on. These were so satisfactory that the company felt encouraged to erect smelting-works at Rush Lake, which were finished in the early fall. Since then these works have been in regular operation, and, as far as I can ascertain, have been successful, both technically and financially. The following statement regarding several lots of ore from the Chicago mine, which were smelted at Jacobs's Smelting-Works, previous to the lot which is mentioned by Mr. Clayton, will give a fair idea of the value of the ores as they can be shipped from the mine:

Statement of the reduction of over a hundred tons of ore.

Date.	Lot.	Sacks.	Gross.	ASSAY.		Moisture.
				Silver.	Lead.	
			Pounds.	*Ounces.*	*Per cent.*	*Per cent.*
October 26, 1872	41	125	13,270	28.57	43.25	4½
	41A	60	5,660	29.37	40.85	4½
	49	552	54,655	30.32	37.75	4½
	52	21	2,350	36.01	68.35	1
November 2, 1872	49A	311	26,330	29.16	37.50	10
	52A	53	5,040	36.45	71.50	2
November 7, 1872	49B	284	25,635	32.08	42.90	7
	49C	378	36,475	28.28	36.75	10
	49D	488	44,705	25.80	39.30	6½
	49E	....	(*)	33.54	30.50	6
Average per ton	....	....	....	30.95	45.60	....

* Return of quantity not yet ascertained.

The following statement of shipments gives an idea of the value of the bullion produced at the Chicago smelter. A car-load is generally 10 tons:

Car-load No. 15 realized	$1,641 02
Car-load No. 17 realized	2,206 97
Car-load No. 18 realized	1,812 25

In *East Cañon* many of the older mines have been worked to advantage during the last summer. Among these may be named, on Mountain Lion Hill, the Mountain Lion group, the Mountain Tiger group, and the Sunnyside group; on Horn Silver group, the Occidental and Silveropolis; on Chloride Hill, the Dixon; on Ophir Hill, the Miners' Delight group, the Grand Burnett, and the McCullin; on the foot-hills, the Green Chloride group.

The Mountain Lion is now well opened by shafts and drifts, as far as this can be done on so very irregular a deposit. This irregularity has caused much fruitless expense; but, nevertheless, a series of good ore-bodies have been developed. The ore produced was rich milling-ore, and has been sent to the Camp Floyd Mill for reduction.

Of the Mountain Tiger group, the Zella has produced the best ore. During the explorations last summer a number of caves were found, the walls of which were incrusted with extremely rich ore. This was worked in the Walker Mill. The latter has worked very little ore, beyond what was found in the Mountain Tiger group, during the whole year.

The Sunnyside has been developed to a depth of 300 feet, and yields from 3 to 5 tons a day. The ore is worth from $100 to $300 per ton.

The Silveropolis, which first produced so much horn-silver, yields now more lead-ore than anything else. Considerable work has been done on this mine.

The San Joaquin, on Chloride Hill, has been opened by works, the linear measurement of which aggregates over 200 feet. It produces now considerable free-milling ore.

On the McCullin mine is a shaft 225 feet deep; a 68-foot level; one of 36 feet; a 12-foot shaft, and a large open cut. It contains decomposed milling-ore.

The mines of the Grand Burnett group contain an ore which is usually called a carbonate, but in fact it is iron ochre containing very little silver and lead. So far, this group has not paid for working.

The Miners' Delight group consists of the Miners' Delight, Velocipede No. 1, Velocipede No. 2, Silver Shield, and several others on Silver Shield Hill. It is owned by the Utah Silver-Mining Company, of England. The mines are extensively opened by tunnels, inclines, shafts, and drifts, in all amounting to over 1,000 feet in length. Several thousand tons of ore have been shipped, but the ore has been poor. Lately, at a depth of 300 feet, a body of ore is reported to have been found which is much richer both in lead and silver. The ore is highly quartzose. On the surface the deposit is over 18 feet wide.

The continuation of the same vein is called the Sevier. There is a shaft on this 120 feet deep, and 6 by 8 feet in section, in which about 8 feet of ore is exposed, consisting of Galena and iron pyrites, with a great deal of zinc. The best ore assays 65 per cent. of lead and 21 ounces of silver per ton. Farther on, along the strike of this deposit, on Chloride Hill, the same layer appears. It is, however, split up very much, and carries mostly a black manganiferous spar, assaying from $20 to $40 per ton in silver. This ore has been worked successfully in arrastras and in the 5-stamp mill known as the Enterprise. Most of the five arrastras of the district have been running pretty regularly and successfully during the year.

The new Enterprise Mill, erected by W. H. Sharp for the Deseret Silver-Mining Company, has also run successfully since its completion, in the latter part of the fall. The other mills, as well as the smelting-works of the district, have been idle during the greater part of the year, and most of the milling-ores of the district have been worked at Camp Floyd.

In *Rush Valley district*, Tooele County, developments have been somewhat retarded by fear of litigation, there being many old "soldiers' claims"* in the district.

The principal work during the year has been done on the Tucson, Our Fritz, Hannah, Muscatine, Silver King, Metropolitan, Legal Tender, Great Basin, and Eureka. On many other mines work has been done to a smaller extent. Nearly all the mines were shut down in December for the winter.

On the Tucson there are two shafts, in which the vein is exposed 2 to 3 feet thick. The ore assays from 15 to 65 ounces of silver per ton.

The Our Fritz has been worked during the greater part of the year. It is a contact deposit, 1 to 3 feet thick, between quartzite and limestone. A shaft is down about 80 feet. A quantity of ore, assaying from 10 to 42 ounces of silver per ton, has been shipped to the Utah Queen and the Chicago furnaces.

The Hannah lies in white limestone, on the only hill of that rock in the camp. The vein runs north and south, cutting the formation at right angles, and is traceable for nearly the entire length of the claim by outcrops of iron, carbonate of lead, and galena. Two shafts have been sunk on the mine, one about 80 feet deep, the other about 70 feet deep. The vein is very uniform in width from top to bottom, averaging about 6 feet, with ore from 1 to 4 feet. The first-class ore assays, in 10-ton lots, 65 ounces in silver and 62½ per cent. lead. Second-class ore, 52 to 54 ounces in silver and 56 to 70 per cent. lead. The ore is composed of galena, dark and gray carbonates, galena predominating. On each side is a streak of green and blue stained quartz from 3 to 4 inches in width. About 80 tons of ore have been shipped during the year, and the proprietors are still shipping quantities of mineral to the Utah Queen and Chicago furnaces, and some to San Francisco.

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* Claims dating from the times previous to the regular settlement of the districts by mining communities, when soldiers marching through the country located claims *en passant*, which, under the loose regulations formerly existing, were often held valid though abandoned and neglected.

The Muscatine, on the same hill, about half a mile from the Hannah, has been worked by four men all the past summer. It has an incline of 140 feet, from which three drifts have been run, all showing from 1 to 4 feet of galena and gray carbonate ores, and assaying from 20 to 40 ounces in silver and 50 to 55 per cent. lead. About 200 tons of ore have been shipped from this mine during the summer. The ores from the last two mines are very good smelting-ores.

The Silver King has a shaft 260 feet deep and tunnels and drifts about 250 feet long. About 1,000 tons of ore have been taken from this mine, assaying 30 ounces of silver per ton and 35 per cent. of lead.

The Metropolitan is opened by about 250 feet of tunneling and shafting. The ore assays 30 ounces silver per ton and 35 per cent. lead.

Situated in this district are several smelters. The Chicago works ores from the Chicago mine. The Utah Queen works ores from the Utah Queen and Rush Valley mines.

Lilly, Leisenring & Co., smelters, late H. S. Jacobs & Co., have been working Fourth of July and Kearsarge ores from Dry Cañon.

The Waterman smelter has been working on Hidden Treasure ore, also ore from Dry Cañon.

American Fork district.—The principal enterprise of this district, that of the Miller Mining and Smelting Company, has nearly come to a standstill. The large ore-body spoken of in my last report was completely worked out during the early part of the year, and in spite of very extensive explorations, by means of a deep tunnel running across the limestone strata, no ore-body of any consequence had been found in depth, up to December. But that the mineral continues in depth is proved by the finding of a small sheet of galena considerably mixed with iron pyrites in the Mormon tunnel, about 550 feet from its mouth. This vein lies between limestone and calcareous shale, and only 15 feet from the quartzite bed spoken of in my last report. In the summer of last year Mr. Epley, an experienced mining superintendent, took charge of the newer mine. After continuing in the vein, for some time, the explorations in depth commenced by his predecessor, he gave up the hope of finding a large body of ore in the hard limestone below, and, following some float ore found on the side of the mountain about 150 feet above the highest tunnel of the old works, he found a small seam of very rich decomposed ore lying almost horizontally across the ridge of the mountain. He started at once the Last Hope tunnel, and following the seam of ore mentioned, he struck a larger body, which turned out very rich in silver, in September, 1873. Mr. Eilers, my deputy, happened to be present when this body of ore was first found. The tunnel was then about 50 feet long, and the seam of ore found at the surface was exposed in the sides of the opening. It was from 6 inches to 2 feet thick. The upper portion was ferruginous carbonate, and below this was a layer of from 2 to 10 inches of very solid and fine-grained galena. At the end of the tunnel the floor layer of ore began to pitch toward the southeast while the roof retained its horizontal position. It was here that the very considerable body of ore afterward disclosed commenced. At the end of the year the tunnel and the works connected with it were 250 feet long. The direction of the tunnel will undoubtedly, eventually, carry it into the works of the Wyoming mine on the opposite side of Miller Hill. The Miller Smelting-Works have been in operation for only a few months, smelting such lots of ore as could be scraped together in the old mining works. The narrow-gauge railroad, which the Miller Company had built up to within four miles of the smelting-works, has been operated rather irregularly, by means of mules. Its principal business has been the transportation of wood and lumber from the upper part of the cañon to the Utah Southern Railroad at Lehigh.

The Wyoming mine is developed by two tunnels and a shaft about 70 feet deep. These works are evidently located on the same body of ore as was struck in the Last Hope tunnel of the Miller. At one time in the fall litigation was imminent between the Miller and Wyoming Companies, but the dispute was finally settled. The Miller Company owns the Wyoming.

The Pittsburgh, Cariboo, Queen of the West, and Roessler mines have been worked more or less during the year.

The Pittsburgh mine, situated northeast of the Miller and across one of the branches of American Fork, is especially well developed by numerous shafts and drifts. There is a very large amount of ore in sight in the mine and on the dump, but it is all of very low grade, assaying only from 10 to 30 ounces in silver. It is, however, very rich in lead, most of the material as extracted from the mine containing over 40 per cent. As the Miller Company has so far not been willing to buy large amounts of outside ore, the mines of this district, being situated high up in the mountains, and being in the hands of the Miller Company, which controls, by means of the railroad, the only outlet from the cañon, have not had any opportunity of realizing on their ores. Large amounts of ore, which is, however, nearly all of low grade, are stored at the different mines. It is reported that in the spring the Miller Company will again begin smelting operations, and that it will hereafter buy all the good smelting ores that are offered.

Tintic district.—The most important work in this district has been done on the Mammoth Copperopolis. The Crismon Mammoth mine, close by, has also been worked nearly constantly. The Mammoth Copperopolis has built smelting-works during the year, for the purpose of making black copper out of the copper-ores in the mine. These works had been in operation for several months, and at the time of the financial panic, when they were stopped, 126 tons of black copper, containing 90 per cent. of copper, and, including gold and silver, worth $252 a ton, had been shipped. From the Mammoth Copperopolis and Mammoth or Crismon mines, 1,209 tons of ore, assaying on an average $24\frac{6}{10}$ per cent. of copper, and worth $59.60 per ton in Utah, were sent to Europe. The mill of the Mammoth Copperopolis Company, which is intended to work the ore from that portion of the vein containing gold in quartz, was running during a part of the year, but it was soon found that the large amount of copper present in the ore impeded operations very much. During the past two years the English company has expended about $160,000 on the mine, mill, and furnaces. During this time an average number of fifty men have been employed. Had it not been for the panic, which, by its great depreciation of the copper in the hands of the company at the time, caused a loss of over $15,000, the company would probably have been able to continue working as before; but as soon as the miners saw that they could not be then paid for past work they struck and took possession of the mine. Immediately after followed an attachment by Wells, Fargo & Co. for a debt of over $13,000. It is now reported that the company intends to raise more capital in England, to extricate itself from its difficulties. The mine is at present developed as follows: by one tunnel 304 feet, and another 300 feet long; four shafts, from 100 to 175 feet deep; four winzes, eight levels, and the necessary tramways.

According to the manager, Mr. S. W. Valentine, the mine can now produce from 10 to 20 tons of copper smelting-ore and from 50 to 100 tons of quartzose milling ore per day. The mill and furnaces are described in the Salt Lake Herald of August 27th as follows:

Roseville is situated among the foot-hills of the range of mountains, extending through the entire length of Tintic district, on the east side of the valley, at their southern terminus, and about nine miles from the Mammoth Copperopolis mine, seven miles from Silver City, five miles southeast from Diamond, two and a half miles from the Shoebridge Reduction-Works, and about the same distance from the Tintic Mill and Mining Company's Mill. From the mine the road follows the valley downward nearly six miles. The balance of the way it is slightly up grade.

The main building of the mill is constructed of wood, upon a hillside. Its foundations are of stone. The mill has 15 stamps of 750 pounds each, in three batteries of 5 stamps each. There are six amalgamating-pans, three settlers, and one agitator. A small car carries the pulp from the battery to the pans. On the southeast side of the mill is situated the retort and smelting room. The pans are driven by the engine, the line shaft passing across the whole mill. The engine-house, situated on the southwest side of the mill, is a large, strong frame structure, resting on a very massive stone foundation. The engine is of 75 horse-power and has a 30-inch stroke, with variable cut-off. There are two 54-inch boilers, 14 feet long, inclosed in masonry.

The ore falls from the dump upon an iron-covered dry kiln; after being crushed in the breaker it passes into the battery. The mill has a capacity of 22¼ tons per day of twenty-four hours.

In connection with the mill this company is erecting a copper smelter, under the direction of Mr. John Williams. This is a frame building 45 feet by 30 feet. The furnace is unfinished, but will contain two stacks made of iron, with boiler-plate water-jackets. The lining will be of Utah fire-brick. Each of these furnaces will have a capacity of 12 tons every twenty-four hours. The motive power is derived from the mill, which is situated 80 feet distant. The water used in this furnace goes into a large tank at the mill, thence into the pans.

Water is supplied from springs over two miles away, and conducted to the works in galvanized-iron pipes.

The Crismon Mammoth and its surroundings are described by Professor Clayton in a late manuscript report as follows:

The geological formation in which the mine occurs is a highly crystalline siliceous limestone. The strata are considerably tilted, the general strike being north and south, and the dip to the east, the latter changing from 15° to nearly vertical. This limestone is underlain at the west base of the mountain by quartzite beds. Toward the east the limestone is joined by granitic rocks. The ore-body has a general north and south course, and dips to the west from 70° to 80°. The deposit is very large, and its width is unknown even at the present time. Some drifts which have been run across what is supposed to be the width of the deposit, have penetrated 100 feet, without finding a solid wall of country-rock in place at the further end. The explorations north and south are of about equal length. They consist of a series of open cuts on the surface covering a space of 200 feet long east and west and 250 feet north and south. About one-third of this area appears to be occupied by ore, which consists of large quartz croppings with here and there iron gossan and green and blue carbonates of copper, in which fragments of country-rock of all sizes are inclosed. In fact the ore looks more like brecciated country-rock than anything else. A shaft has been sunk at a point near the center of the outcrop to a vertical depth of 213 feet. At 120 feet in depth tunnels were run north and south. Both shaft and drifts are entirely in ore. From the western base of the hill a tunnel has been run toward the ore-deposit 410 feet, at which point good ore was first struck. Two main drifts have been run from this point, one obliquely to the right or southeast, and one toward the northeast. Though both drifts have been run for long distances no walls have been found. From these explorations Professor Clayton estimates that about 100,000 tons of ore were in sight in the mine at the date of his letter, of which one-quarter was 25 per cent. copper-ore. Of the rest he thinks 25,000 tons could be saved for the mill process, this being ore carrying silver and gold to the amount of $30 to $50 per ton, and little copper.

On the Joe Bowers lode, near Diamond City, the Wendigo Company has done a little work during the year. From that portion of the vein owned by Messrs. Tostavin, Jeffries & Co., about four tons of ore have been shipped for sampling. The assay gave $83 per ton. The great mass of the ore is, however, much poorer, its value, as indicated by many assays, being about $46 per ton.

On the Shoebridge mine the old shaft has been enlarged, and hoisting-works have been erected. Drifts have been run from this shaft at a point 125 feet from the surface. The vein is found from 3 to 4 feet wide and contains copper-ores combined with arsenic and sulphur, and carrying some silver. The company's mill, which contains an Aiken roasting-furnace, has worked during a part of the year.

The Otsego Silver Mining Company, owning the Gold Hill, May Flower, and Tessora mines, has shipped about 1,000 tons of ore to the Tintic Mill and Mining Company's mill up to January 1, 1874. The shaft on the May Flower is 130 feet deep, and three levels, respectively 75, 25, and 35 feet long, have been run from it. The May Flower tunnel, connecting with the Gold Hill shaft, which is down 90 feet, is 316 feet in length, near the end of which is sunk May Flower shaft No. 2, to a depth of 30 feet. The Tessora has a shaft sunk on it to a depth of 140 feet, with drifts running in opposite directions on the vein.

At the Morning Glory mine there is a shaft upon the summit of the ridge, near the north end of the claim, 100 feet deep, which contains copper-ores and copper-stained quartzite. At the lower shaft of this company, about one-third of a mile northwest from Diamond, the most work has been done and a good deal of copper-ore has here been raised. Only a few tons of it have, however, been taken to the Tintic Mill and Mining Company's mill.

The Norwegian, Victor, Julian Lane, Golden Treasure, and others are located in this vicinity and have been worked during the year.

The Susan mine, situated about a mile and a half southwest of Diamond City, lies in granite. The vein is from 2 to 6 feet wide, the ore occurring in streaks and bunches in a quartz and feldspar gangue. It is opened by two shafts 180 feet and 20 feet deep. At a depth of 120 feet in the first shaft a level has been run northeast along the vein for about 30 feet, exposing good ore. That so far extracted assays from $25 to $150 per ton in silver. In the vicinity of Silver City occur a great number of small argentiferous lead veins in granite, on many of which considerable exploring work has been done; but no large deposits of this ore, which assays from 28 to 50 per cent. of lead and from $30 to $100 in silver and gold per ton, have as yet been found. The Black Dragon, Sunbeam, Snaky, and Sidney are considered good mines and have been fairly opened.

The Eureka Mining Company's property was sold by Messrs. Lawrence & Whitney to Captain E. B. Ward and other parties in Detroit during the year. The representations of the vendors in regard to the value of the ores not being borne out by the subsequent mining experience of the new owners, Mr. Ward has taken legal steps to recover the money paid for the property, so far without favorable results. There has not been much work done at these mines during the year.

Of the mills in this district the Tintic Mill has been running with the greatest regularity, but only for the latter part of the year. It shipped for a time from $1,000 to $1,500 worth of silver bullion weekly.

Camp Floyd district.—The principal mines of this district are located on a bed of quartzite which is irregularly impregnated with silver, iron, copper, and zinc ores. The English company, known as the Camp Floyd Mining Company, which owns the Sparrow Hawk, Last Chance, and Marion, ceased early in the year to work its own ores in its splendid 20-stamp mill, because, as I am informed, the large masses of ore, as they come from the mines, are very difficult to assort, and of too low grade to pay for extraction and milling without sorting. About 2,000 tons of ore have been taken from these mines altogether. The company's mill has, however, been running on custom ores during the greater part of the year. According to the advertisement of Mr. Henry Sewell, the resident manager, the following is the scale of prices paid at the mill:

Ore assaying per ton—	Per cent. of assay paid.
$40	25
50	30
60	35
70	40
80	43
90	46
105	50
130	57
150	60
$175	63
200	65
225	67
250	68
300	73
350	74
400	75
500	78
600 and upward.	80

Up to the end of November there had been 56 bars of bullion produced at the mill, which were worth over $52,000 coin. The value of the tailings on hand at that time is stated as $40,000.

Some prospecting has been done during the year on the above-named mines, but so far without any encouraging results.

The Camp Douglas, Gentile Belle, and Elkhorn have also been prospected without finding any considerable bodies of ore.

The Queen of the West is well developed and has been steadily worked. This mine is owned by a Detroit company. At the end of the year the good part of the ore was worth $200 per ton, and between 2,000 and 3,000 tons were on the dump and in sight in the mines. Several other mines in the district have been worked during a part of the year, but in none of them have very encouraging prospects been found.

In Camp Floyd several deposits of cinnabar have been discovered. On the Jenny Lind an incline 50 feet deep has been sunk. Experiments made with several hundred pounds of ore gave the average percentage of quicksilver in the assorted stuff as 4 per cent. The New Idria is located on the same vein as the one just mentioned. In a 20-foot incline sunk on it 4 feet of ore are reported to be exposed. It is of the same value as that from the Jenny Lind.

Parley's Park, or Uintah district.—This district is subdivided into three, the Uintah, Howland, and Blue Ledge. The principal mines in these are the Piñon, Walker, Webster, Bob Tail, Pioneer, Idaho, Gregory, Flagstaff, McHenry, Dolly Varden, Ontario, and Cariboo. The Walker, Webster, and Piñon were among the first discovered, and have been considerably developed.

The Flagstaff lies on the divide between Parley's Park and Provost Valley. The ore-deposit runs north and south. There is an inclined shaft on the vein. At a depth of 90 feet a drift has been run along the vein, which is here, in places, over 10 feet wide. The incline is down altogether 220 feet. The ore is a good smelting ore, and is reported to contain on an average $40 to $50 per ton. Some of the ore has been shipped to furnaces in the valley, but next season the owners intend to put up works of their own at the base of the mountain.

The Ontario mine is opened by a tunnel running along the vein for 740 feet, and by three shafts, respectively 98, 123, and 100 feet deep. At the main working shaft hoisting and pumping works, driven by a 40 horse-power steam-engine, have been erected. The ore is milling ore of more than average grade, and a good deal of it is reported to have been shipped. Some 200 tons from the mine were sampled at the Pioneer works in Salt Lake.

The Piñon mine is opened by a shaft 100 feet deep, and contains very good smelting-ore, a mixture of carbonate and galena. The mine has shipped considerable ore during the year.

The Walker and Walker extension of the Buckeye is owned by the Wahsatch Mining Company, organized in 1872, with a capital stock of $1,000,000. The vein lies in slate and limestone, ranging from 3 to 5 feet in width, and crops out along the surface of the mountain. It has been stripped some 350 feet, showing ore all the way. About $20,000 have been expended on this mine. The Democrat tunnel is intended to tap the Walker and Walker extension of the Buckeye at a depth of 300 feet from the surface. The Walker tunnel, on the same mine, follows the vein for over 100 feet. An incline runs from this tunnel, following ore all the way for a distance of 120 feet. The Buckeye tunnel follows a vein of ore about 5 feet in thickness, and has been completed about 100 feet, including drifts. Other cuts and drifts show ore from a foot to 18 inches in thickness. The ore from this mine is both milling and smelting, and of an average value in silver of $50 in mass. Assays as high as $214 have been received. Three hundred and fifty tons of ore are now on the dump awaiting treatment. Unusual facilities in the way of water and timber exist near this property for the erection of mills or smelters. It is distant only twenty-five miles from the Coalville and Echo Railroad.

Adams district.—This is a new district formed July 3, 1873, in City Creek Cañon, seven miles from Salt Lake City. No important result has been reached in any of the numerous claims located here lately, but on some of them considerable work has been done, showing that the ores of the district are lead-ores, mostly poor in silver, and iron-ores. Of the latter 200 tons and of the former 80 tons were shipped during the latter part of 1873.

A late number of the Utah Mining Gazette describes some of the claims in this district as follows:

> The Julia lode was the first claim located in Adams district, having been discovered May 29, 1873. A shaft has been sunk to the depth of about 40 feet, showing mostly carbonate of iron.
>
> The New Jersey was discovered June 1, 1873, and presented almost at the surface a vein of 22 inches of galena, assaying 30 ounces in silver and 74 per cent. lead. A shaft has been sunk to the depth of 30 feet, and the vein has run into pockets. About 50 tons of ore have been shipped from this claim and sold to Salt Lake parties.
>
> The Idaho lode was located June 19, 1873, and about $500 in work has been done on this mine. A prospecting-shaft has been run through a series of pockets, showing a small quantity of galena.
>
> The Richmond, a prospect of very encouraging appearance, was located June 26, 1873. But little work has been done on this claim, as also the El Dorado, Nixon, Rob Roy, Catherine, New York, and Susquehanna. All of the above claims are located in Dry Gulch.
>
> On Scott Hill are located—
>
> The General Scott, discovered June 21, 1873. A shaft has been sunk to the depth of 58 feet, having a vein of ledge-matter, averaging 3 feet, with a well-defined hanging-wall dipping into the hill. On this mine are comfortable quarters built for the workingmen, including shaft-house, blacksmith-shop, &c.
>
> The Red Bird, located June 22, 1873, has a shaft sunk about 55 feet, and the owners have abstracted therefrom about 200 tons of ore, assaying from 18 to 40 ounces silver, 23 per cent. lead, and from 10 to 15 per cent. iron.
>
> The Summit lode, a claim owned by the same company and located June 21, 1873, has comfortable work-houses and dwellings. A shaft has been sunk 53 feet, and about 75 tons of ore are on the dump, assaying from 18 to 32 ounces silver and 40 per cent. lead.
>
> The Henry lode, located June 21, 1873, has a shaft sunk 60 feet, showing a 3-foot vein of ledge-matter, interspersed with small quantities of galena, assaying as high as 40 ounces silver.

The Victorine, situated on the north Mill Creek slope, has a shaft of 65 feet, and a ledge of vein-matter averaging 4 feet in width, with good hanging-wall.

The Chipmonk, located on Nixon's Peak, has a prospect-shaft of 20 feet. Small quantities of galena are interspersed through blue limestone seamed with spar.

In Cottonwood Fork are situated twelve locations, eight being the property of Messrs. Houtz, Robinson & Hampton; the Tycoon, and H, and R being 5-foot veins of hematite iron, of superior quality for fluxing.

The San Domingo, located July 5, 1873, has an incline run in about 70 feet, showing a vein of high-grade galena and carbonates, some assaying 300 ounces. This claim has shipped about 50 tons, and has about 10 tons on the dump.

Lucien district.—The Tecoma Mining and Smelting Company of Utah and Nevada, a New York company, has done very little besides exploring its mines and smelting during a short campaign the ore which had accumulated since the mines came into possession of the company.

These mines, the Tecoma, Sunset, Morning Star, and Empire, are noteworthy, and have acquired quite a reputation for the occurrence of wulfenite, (molybdate of lead.) This mineral occurs in very large crystals and in great abundance. In fact, in some of the workings almost no other lead-bearing mineral was found.

From the explorations of the previous year the company had 650 tons of ore on hand and about 350 more were extracted in the prospecting work during 1873. In the fall the company rented the smelting-works of Messrs. Buel & Bateman, at Buel City, one and a half miles from the mines, and engaged Mr. A. Wartenweiler, of Salt Lake City, to smelt the ore on hand. To this gentleman I am indebted for notes on the result of this campaign. The ore to be treated was a mixture of galena and oxidized ores, the latter consisting largely of the above-mentioned wulfenite. Very soon after starting the furnaces it became evident that the ore would be troublesome to treat. On the reduced lead in the hearth and in the siphon tap a stiff scum would form, which in a few days would grow to a thick layer, and cause accretions all around the walls of the hearth. It was at all times perfectly easy to push iron tools through this layer to the bottom of the furnace, but it would not become liquid, and had to be pulled out from time to time with the slag, from which it separated imperfectly. Every two or three days the breast of the furnace would have to be taken out in order to clean the furnace. Mr. Wartenweiler had no laboratory or chemical reagents on hand to test this strange material, and was afterward occupied by other business, so that up to this time he has not been able to investigate the scum. The impression is, of course, that the molybdate of lead in the ore has something to do with the formation of this product, which is likely to contain so large an amount of sulphide of molybdenum as to render it almost infusible.

The result of smelting these 1,000 tons of ore was 270 tons of lead, containing on an average 100 ounces of silver and ½ ounce of gold per ton. After the campaign was over, all work was stopped in the mines of the company.

The English Tecoma Company has also done principally exploring work during the year. This work was not successful, as appears from the following abstract of report, bearing date of October 30, by Mr. R. St. Stephens, the superintendent sent out from England in August, 1873, to replace Messrs. Maxwell & Forbes, who were at the same time managing the Flagstaff and Last Chance mining properties, over 200 miles away, in Little Cottonwood and Bingham Cañons in Utah.

At the Gladstone location, owing to the somewhat unfavorable character of the lode, and the extreme compactness of the limestone rock, very little work has been done, and all operations were suspended until a more convenient opportunity presented itself. At the Shanley location, at Discovery or Shanley shaft, sunk by the original proprietors to a depth of 70 feet, at an angle of 45°, and running down with the lode, in the back or hanging-wall, as also on foot-wall, are indications that a large body of ore had been taken out, the vein varying from 2 feet in thickness to 6 feet, then breaking into "shoots" tending in a southeasterly direction, with occasional pockets of rich carbonate ores. At a depth of 54 feet a level—the north drift—was run in a northerly direction 161 feet, for 70 feet following the course of the vein, which varied in width from 6 inches to 6 feet, increasing at a distance of 22 feet from the shaft to 8 feet in width, with good, defined walls. At this point No. 1 winze was started, but after sinking 10 feet the ore gave out, the vein-matter changed into iron, and the lode bearing away west, parallel to the slope of the hill, further work was discontinued. On commencing No. 1 winze, a string of ore was observed on the hanging-wall, which was traced by No. 2 winze to a depth of 6 feet, but the vein bending away under the north drift it was followed for 26 feet, when, the ore again giving out, this winze was abandoned. At 72 feet from the Shanley shaft connection was made with the Maxwell shaft for air, and north of this connection No. 4 winze was sunk to 9 feet, but very little ore found. From this point to the end of the north drift, a distance of 74 feet, a few bunches of ore were discovered, but none of any value. At 10 feet from above north drift (and in the shaft) stoping was commenced on a piece of ore-ground, which ran up to the surface in the form of a "shoot" or "chimney," varying in thickness from about 1 foot to 2 feet, coming out at the Maxwell shaft, 72 feet above. The drift running south from the shaft, and in a line with the north drift, was run by the first owners for a distance of 34 feet, and within a short distance from the starting-point it opened out into a chamber of ore 8 feet deep, showing the ore as being continuous. At 34 feet from shaft a rise was started to surface for air, a distance of 55 feet; in this rise several bunches of ore were found. From bottom of the air-shaft a drift was run in a southwesterly direction for 10 feet on a thin ledge of ore, but as it gave out the driving was stopped; a cross-cut was also run in 10 feet in a southerly course. At 30 feet from shaft a cross-cut was driven easterly, and after 10 feet had been run it opened into a bonanza, which, after removing the waste-matter that had fallen from the roof, measured 25 feet in length, 23 feet in width, reaching to a height of 10 feet. On cutting through the ore, by means of cross-courses, it was found to vary from 1 inch to 4 feet in thickness; but it was considerably mixed up with waste-matter, the greater portion now lying on the dump. After further explorations, a cave was opened into 54 feet from starting-point; for the last 20 feet it was 10 feet wide, and dipping at an angle of 37°. Underlying the vein-matter the rock was decomposed in places for a depth of 10 feet; ultimately the walls closed in on all sides, leaving not a trace of ore to follow. On breaking into this cave, or bonanza, it was thought—the appearances exhibited being so favorable—that large quantities of very rich ores were exposed; these anticipations, however, proved most illusory on further development, as the total quantity of pay-ore sacked did not exceed 30 tons. In a southerly direction from the cave a drift was run 35 feet, following a small vein of galena ore, but the hard blue limestone rock being too expensive to drive in the level, was abandoned, especially as the adit-level would prove this part of the ground, and save the no inconsiderable expense of hoisting. At the Orbit location, a shaft, 100 feet west of the Maxwell, has been sunk 25 feet, on a small vein of ore; the vein at the bottom of the shaft becoming pinched, and sinking too expensive, having in view the limited amount of funds at disposal, the men were removed to the Lumsden location. The Lumsden shaft, 84 feet southwest of the Shanley, and on alignment with the mouth of the Stanford tunnel, was, at the time of Mr. St. Stephens's arrival, sunk to a depth of 88 feet. At 50 feet from surface a landing was made, and two drifts were run, one north for 30 feet, through a body of iron-ore, and the other south for 15 feet, also through iron-ore. At the latter point about 6 tons of good ore were extracted. This important part of the mine will be further explored at a future date.

The initial point of the Stanford tunnel is situated outside the original Lumsden location, and in a claim recorded by McElroy & Co. It was manifest that the power to run the tunnel through this neighboring claim would be of the greatest advantage to the company, not only on account of tapping the Lumsden and Shanley shafts at a considerable depth, but also for the disposing of the *débris* and tramming out the ore. With these objects in view, Captain Gray, then agent at the mines, entered into an agreement with McElroy, by which the necessary permission was obtained. In the Shanley (112 feet) bunches of iron and galena ore were met with, but nothing of importance until within 10 feet of the connection, when a body of ore was struck which continued in a fine lode to the head of the tunnel, varying from 3 inches to 3 feet in width. In driving the tunnel, about 25 tons of galena-ore have been extracted. Three separate assays of samples taken from different points give the following results: Sample No. 1, 37 per cent. lead, and $47 silver; sample No. 2, 63 per cent. lead, and $47.13 silver: No. 3, 75 per cent. lead, and $73.82 silver. Within the past few days an almost vertical vein of good galena-ore (splendid smelting-ore,) within well-defined walls, has been discovered in close proximity to the Lumsden shaft, and upon this vein tunnel winze No 1 is being sunk; it is now down 15 feet, the lode still running at the same favorable inclination. The whole of the mines are now accessible through this adit.

Later in the year, on the 24th of December, Capt. J. Y. Gamble reported regarding the work at the mines during November, by order of Mr. St. Stephens, who was absent at the time, as follows:

> The Gladstone location: It has not as yet been found expedient or possible to recommence operations at this mine. The Shanley location: At the connecting-point of the Shanley shaft and the Stanford tunnel a small vein of ore was discovered. A drift was at once commenced, and driven through numerous pockets of rich galena, producing several tons of excellent pay-ore, but the indications did not warrant the prosecution of the works any further in this direction. The Orbit location: No work, other than to the extent mentioned in the last report, has been done in the Orbit shaft. The Lumsden location: In the report of the 30th October, reference was made to a drift which had been run in a southerly direction 15 feet from the 50-feet level through a body of iron-ore, and, as this is considered a very important part of the mine, the drift was continued for a few feet, still exhibiting improved indications, till the end of November, when all work was suspended throughout the company's property. A shoot has, however, been erected in the Lumsden shaft to the Stanford tunnel, in order to facilitate the disposal of waste matter, and the transit of the ores to the loading platform. The Stanford tunnel: This tunnel has been extended 40 feet during November, but at that point the lode pinched out, the ground was found to be broken and loose, and the driving of the end of the tunnel was therefore discontinued; but, in close proximity to the Lumsden shaft, a branch lode was discovered, which produced several tons of good galena ores. McElroy and Co.'s location: Messrs. McElroy and Donnelly continued to work on their neighboring claim till about the 20th November, and sunk their shaft to within a few feet of the Stanford tunnel, when they desisted, and have not since offered any further interference with the company's rights.

The above reports show that at the end of the year the Tecoma Company was not in an enviable position, especially as all the working capital had been used up. Only about 400 tons of ore had been extracted altogether, of which 160 tons had been smelted at the company's smelting-works, producing 40 tons of bullion worth $180 per ton. These works are located at Truckee, on the Central Pacific Railroad, about 500 miles from the mines.

In view of the fact that this English company purchased the mines in question at £280,000, on the report that 3,900 tons of ore, worth $736,000, were in sight, the disastrous result of further developments has naturally aroused much anger as well as disappointment. But the purchasers in this instance employed no expert in their own interest to verify the statement of the vendors; and the person who made the glowing report upon which the enterprise was based was an English mining manager. Under these circumstances, as in many similar cases, the cry of "American swindling," which has been rather freely indulged, seems decidedly out of place.

Star mining district.—For the following report on this district I am indebted to Major M. A. Baldwin, who spent much time in the district during last summer:

The district is situated two hundred and ten miles south and forty-three miles west of Salt Lake City. The Utah Southern Railroad, projected south from Salt Lake City to Saint George, is completed for a distance of about fifty miles, and passes within ten miles of this district.

The formations are limestone, quartzite, and granite. There is a scarcity of wood and water near the mines, but four miles from the mines both are abundant.

The district has a great number of lodes, which appear to be permanent and distinct. Many of them are said to be contact fissures. There are over 900 locations on record, and all of them have been worked as the law rerequires. There are nearly 200 distinct lodes. Those found in the granite and quartzite contain principally milling ore, and carry some gold. Those found in the limestone and the contact lodes contain either argentiferous galena or carbonates carrying silver. The two latter contain sufficient iron for fluxing in the furnace. The table below will give an idea of the extent and richness of the ores of this district.

There is in successful operation a mill of 10 stamps and a furnace having a capacity of 20 tons of ore per day. The ores milled have been obtained principally from the Hickory mine, and yield $100 per ton. The furnace has smelted ore from scores of mines, most of which are paying well and produce base bullion worth about $300 per ton. Freight to the railway is $30 per ton.

Name.	Length.	Character and length of opening.	Drifts.	Character of ore.	Width.	Extracted.	Yield in silver ore, per ton.	Yield in lead, per cent.	Yield in copper, per cent.
	Feet.	*Feet.*	*Feet.*		*Feet.*	*Tons.*			
Hickory	1,200	Shaft, 180	200	Milling	3	700	100	10	Trace.
Temperance	1,200	Shaft, 130	280	Milling	2½	300	90	15	Trace.
Shenandoah	1,200	Shaft, 60	......	Milling	2	40	60	......	
Flora	1,200	Shaft, 130	30	Smelting	3½	500	90	25	Trace.
Rebel	1,200	Shaft, 84	75	Smelting	4	300	60	40	
Hidden Treasure	1,200	Shaft, 46	......	Smelting	2	50	80	15	
Osceola No. 1	1,000	Shaft, 60	......	Milling	3	40	50	10	Trace.
Osceola No. 2	1,000	Shaft, 60	20	Milling	3	80	50	10	Trace.
St. Mary	1,000	45° incline, 60	60	*Smelting	3	80	100	25	
Carter	1,000	Shaft, 30 Tunnel, 200	......	Smelting	1	30	200	35	
Blue Cloud	1,000	Shaft, 60	......	Milling	3½	100	65	......	Trace.
Lookout	1,000	Incline, 46	......	Milling	1	10	400	20	Trace.
Eureka	800	Shaft, 30	......	Milling	8	20	200	......	Trace.
Banning Moscow	1,000	Shaft, 80	......	Smelting	3	100	80	34	
Elephant	1,000	Incline, 80	......	Smelting	2½	200	50	60	
Midas	1,200	Shaft, 70	......	Milling	2	60	100	......	Trace.
Dead Beat	1,000	Incline, 75	......	Smelting	1½	60	85	46	Trace.
Morehouse	1,000	Incline, 80	......	Smelting	1½	30	85	30	
Boston	1,000	Shaft, 70	......	Smelting	2	100	60	20	
Minnesota	1,000	Shaft, 100	......	Milling	6	40	70	......	Trace.
May Flower	1,000	Incline, 100	......	Smelting	2	30	150	......	
R. E. Lee	1,000	Shaft, 20	......	Smelting	4	12	120	40	
Wild Bill No. 2	1,000	Incline, 40	......	Smelting	3½	200	80	40	
Clipper	1,200	Shaft, 112	......	Smelting	2	50	75	40	
Lake Superior	1,000	Shaft, 30	......	Smelting	20	200	15	......	15

* Carbonate.

Ohio mining district.—I have not received a report on this district from my correspondent in Utah, nor could the locality be visited by myself or my deputy. I attach, however, sufficient importance to the developments made in the district to insert here an abstract from an article by Mr. B. A. M. Froiseth, which appeared in the Salt Lake Mining Gazette:

> Ohio mining district is situated about six miles south of west from the settlement of Marysvale, on the Sevier River, Piute County, Utah, and about two hundred miles south of Salt Lake City.
>
> The district was organized in February, 1868; is about ten miles square, and contains over five hundred locations. The names of the camps are Bullion and Webster Cities. The former is well located in Piute Creek Cañon, and has lately become the county seat of Piute County.
>
> It contains some 200 inhabitants and from forty to fifty dwellings. A fine stream, called Pine Creek, runs to the south of Bullion, and empties into the Sevier River. There is an abundance of the best of timber and water for all mining purposes to be found in the vicinity.
>
> The Piute Mining Company has erected a stamp mill at Webster City, with a capacity for crushing 30 tons of rock per day, which has been run in the reduction of ores taken from the mines belonging to the company. Between Bullion City and the Homestead mine five mill-sites have been surveyed and located.
>
> The principal mines are as follows: Daniel Webster, situated on the south side of Pine Creek, above Bullion City; improvements consist of a shaft 42 feet deep, at the end of a tunnel 50 feet long; an incline near the mouth of the shaft and another tunnel 30 feet deep at a point 430 feet farther south. Some of the ore has been worked

by milling, yielding $106 per ton in silver and gold, but the average of all the ore is probably below $50 per ton, the former metal predominating. The lode has been traced by the outcroppings for a distance of 2,000 feet; vein nearly vertical, with an occasional inclination to the west. Homestead, located in Pine Gulch; improvements consist of a shaft 6 by 9 feet and 130 feet deep, and an open cut and tunnel 150 feet deep across the vein. Some ore carries from $5 to $32 in gold, but the general average, as found by a large sample taken in 1871, by Mr. J. F. Boyd, is $9 in gold and $47.15 in silver per ton;[*] vein nearly vertical; mine is in porphyry and trap; timber abundant in the vicinity. Saint Lawrence: incline 55 feet deep, exposing the vein, which shows milling ore; average of several assays gives about $30 in silver per ton and a trace of gold; foot-wall quartzite; hanging-wall, granite; abundance of timber in the vicinity, and the mine is accessible by a good road. Great Western, on north side of Pine Gulch, above Webster City, developed by an incline 50 feet deep, which shows the lode to be 7 feet in width; vein dips northwest; ore averages $85 in silver per ton; porphyry, trap, and granite predominate in the vicinity of the mine. Niagara, on the south side of Pine Gulch, above Webster City; discovery stake below a high, rocky cliff, from where a tunnel runs in 75 feet; lode can be traced by croppings for several hundred feet; average assay of ore, $100 in silver per ton; porphyry and trap in the vicinity.

Besides the above, Mr. Froiseth mentions the Belcher, Union, Golden Curry, Jackson, and several others as promising mines, on which work has been done.

Desert district has been organized some fifty miles southwest of Stockton. It contains large deposits of lead-ores, rich in lead, but poor in silver. The Salt Lake, Sevier Valley and Pioche Railroad will pass within eight miles of this district when completed. At present these deposits cannot be utilized on account of their low grade.

Uintah Valley district, forty miles southeast of Fort Bridger station on the Union Pacific Railroad, is said to contain many deposits of carbonates of lead and galena.

Mount Nebo district, situated eighty-five miles south of Salt Lake City, in Juab County, lies within only a mile and a half of the proposed line of the Utah Southern Railroad, which is now finished to Provo City, thirty-five miles from the mines. The latter contain, according to all accounts, extraordinarily large deposits of lead-ores, containing from $18 to $30 in silver, which cannot be utilized until the railroad reaches the district. Among the important mines of the district the Olive Branch, Mountain Queen, Monitor, Magpie, Eureka, and Morse may be mentioned. On the latter location there is an incline 140 feet deep.

Drum district is situated about one hundred and fifty miles south of Salt Lake City. A few copper-veins have been located here, of which the Mammoth, Democracy, Messenger, and Yuba Dam are the most prominent. The ores so far mined, of which there are only a few tons, carry about 40 per cent. of copper and from $30 to $60 in silver per ton.

Newfoundland district, situated about twenty miles south of Terrace, on the Central Pacific Railroad, and one hundred and five miles by the railroad from Salt Lake City, is in a mountain-range about twenty-five miles long and two and one-half miles wide. Some silver lodes occur here in limestone, and several copper lodes have been found in quartzite. On the Margaret a shaft 20 feet deep has been sunk, in which ore, assaying $125 in silver per ton, has been found. The Telegraph and Rattler are the names of two copper-veins, which are reported to contain 40 per cent. copper-ores.

In *Osceola district*, situated in the Snake range, about two hundred and twenty-five miles southeast of Salt Lake City, some gold-bearing veins with free gold on the surface have been discovered. The ore turns into auriferous sulphurets of iron at a slight depth.

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[*] Another sample of over a ton, taken to Salt Lake City and crushed at Mr. Johnson's sampling mill, assayed $3.10 in gold and $37.88 in silver.—R. W. R.

CHAPTER VI.

COLORADO.

My estimate of the product of this Territory during 1873 has been carefully made, upon data given in the following pages, and private information from other sources. I am specially indebted to Mr. T. F. Van Wagenen, editor of the Georgetown Mining Review, for valuable assistance. The following statements differ somewhat from those published by Mr. Van Wagenen, in January, 1874, in the journal referred to; but this is the natural consequence of the better opportunity offered by the later date of this report for the correction of various items, and the substitution in some instances ofofficial reports for estimates.

The product of gold and silver by counties was nearly as follows:

Gilpin	$1,440,502
Clear Creek	1,204,761
Boulder	390,000
Summit	106,000
Lake	230,000
Park	459,000
Conejos	15,000
Bullion bought by manufacturers, shipped, in private hands, &c	175,000
Total	4,020,263
To which may be added the estimated value of coal raised	1,275,000
And of pig-lead shipped	28,000
Giving as total of annual products	5,323,263

The product of gold and silver above given includes bullion, ore, and matte, and may be classified as follows: (These figures are, as will be seen, merely estimates in round numbers.)

Gold from placers and gulches	$409,000	
Gold from stamp-mills	995,000	
Total gold		$1,404,000
Silver bullion from amalgamation	647,000	
Silver from Black Hawk Separating-Works	192,000	
Total silver		839,000
Matte shipped to England		1,003,000
Ore shipped to Golden, Denver, and out of Territory		771,000
Unclassified		3,263
Total		4,020,263

Further information concerning the mining industry of the Territory is contained in the reports from the different counties, which exhibit, on the whole, a highly encouraging condition of progress and promise.

GILPIN COUNTY.

For a report on this county I am indebted to Mr. G. H. Gray, now territorial assayer at Central City in place of Mr. A. Von Schulz, resigned.

Mr. Gray says, in his statement of the product of the county during 1873, that the Colorado Central Railroad Company has transported during the year 1,426 tons of Gilpin County ore, the correct value of which cannot be ascertained. But as the class of ore shipped was well known, it was not difficult to estimate its contents from the known value of that class of Gilpin County ore, which rarely varies now in grade from year to year. In the estimate of the value of ore purchased by the Boston and Colorado Smelting Company, Mr. Gray has included the ore obtained from Boulder County and a small amount obtained from the extreme east end of Clear Creek County. His statement is as follows:

Shipment of gold through Wells, Fargo & Co.	$710,996
Purchased by Boston and Colorado Smelting-Works	580,635
Purchased by United States Smelting-Works	45,000
Purchased by Swansea Smelting-Works	12,000
Value of 1,426 tons of ore shipped by Colorado Central Railroad	109,871
	1,458,502
The amount bought by the Boston and Colorado Smelting Company from Boulder and the east end of Clear Creek County I estimate, according to the best data on hand, at	18,000
Leaving product of Gilpin County	1,440,502

Besides the above amount of gold, Messrs. Wells, Fargo & Co. have shipped $20,000, which, however, came from Clear Creek County. The $299,776.13 silver bullion shipped during the year by the same parties, belongs to the product of Clear Creek and Boulder Counties.

Mining in Gilpin County during the past year has been, upon the whole, progressive, although at the end of the year there were very few mines working. If there could be some way devised by which water could be brought to the mines, it would enable a great many to work which are now lying idle. The mines must be worked in the most economical manner, and hoisting by steam is not very economical in Gilpin where fuel is so high. The mines are not as rich as was at first supposed, but they can be worked at a profit if worked properly. At the Briggs mine, owned by the Briggs Brothers, they are mining, raising, and milling at a profit, ore running only $40 per cord. Smelting-ore assaying as low as $60 per ton is now sold at a good profit to the miner. At the Leavitt mine, owned by B. S. Buell, great improvements are taking place. They consist in the erection of a 60-stamp mill close to the mine, and the raising of the ore in cages instead of buckets. Cars will be filled in the galleries, and then run on to the cages and raised to the surface. The cars are then run to the stamps and their contents deposited. Within the last quarter of the year the Consolidated Gregory and Bobtail Companies have resumed work after a suspension of nearly four years, and by spring expect to be producing large amounts of ore. Several smaller companies have expressed a desire to begin work again in the spring.

The subject of concentration of ore has attracted considerable attention of late. The old Keith Mill, situated in Chase Gulch, has been purchased by a New York company for the purpose of concentration. The wet process will be employed, and it is their intention to use the Collom jig, which has been in successful operation at Idaho Springs, Clear Creek County, during the past summer. Too much importance cannot be attached to this subject, as it is of vital importance to the mining of low-grade ores.

The smelting interest remains in about the same condition as last year. The Boston and Colorado Smelting Company is still the only one in the county. There are at present prospects of a lead-smelting company starting in the county next spring.

The Boston and Colorado Smelting Company has, since it commenced operations to within a few months ago, shipped its copper matte to Swansea, Wales, for separation. During this summer, however, the company has erected separating works of its own, which turned out the first silver, .998 fine, early in November. Since that time regular shipments of silver have been made, but no gold has as yet been sent away.

A full description of the process of separation here followed I defer to my next report, especially as not all parts of the process are as yet definitely settled and accepted. I will here only say that the general plan, as worked at present, follows the Ziervogel process in the extraction of the silver from the copper matte, while the residue, containing copper and gold, besides large amounts of lead, zinc, antimony, arsenic, &c., has so far been smelted into black copper, which is granulated and dissolved in hot sulphuric acid under access of air. The gold remains in the residue, which is either added to a lead-bath in a cupelling furnace, from which the gold is obtained in a button, or first reduced and then cupelled. This process is, however, costly and impracticable at Black Hawk, because the residue spoken of is very large, thereby necessitating the use of very much lead, which is finally lost in the course of many repetitions of the process. The sulphate of copper resulting as one of the products of the process must be shipped East to find a market, while the sulphuric acid is imported. Under these circumstances experiments are still going on at the works to find a more suitable process for the extraction of the gold.

CLEAR CREEK COUNTY.

For the report on this county I am indebted to Mr. H. Stoelting, mining engineer, territorial assayer at Georgetown, who, with the assistance of Mr. B. F. Napheys, has succeeded in gathering all the important information in regard to the development of the industry in this county and the neighboring one of Summit, and in collating entirely trustworthy and authentic statements of the yield of both counties. I have, as usual, made some alterations and additions, suggested by personal knowledge or judgment, and information from other sources; but in this instance the changes incident to a revision of the notes furnished me have been both few and slight.

The production in Clear Creek County of gold and silver bullion and ores during 1873 has been as follows:

Bullion and ores.	Tons of ore.	Value.	
1. Gold and silver bullion:			
J. O. Stewart's works*	2,200	$325,000 00	
Masonville works*	200	20,263 46	
Placer gold		34,000 00	
	2,400		$379,263 46

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* The quantities of ore treated at Stewart's works and at Masonville are given in round numbers, and not from exact records. The grand total of tons treated and shipped is therefore only an approximation, though I believe a very close approximation, to the actual quantity. The shipments East include those to Europe.

Bullion and ores.	Tons of ore.		Assay value.	
2. Ores shipped East:				
G. W. Hall & Co	428		$225,251 44	
Wm. Bement	136		45,000 00	
J. G. Pohle	85		47,000 00	
Terrible Mining Company	110		70,000 00	
Pelican Company, L. Egyers; Baltimore Company, H. Iselin, Jones, and others	160		54,500 00	
		919		$441,751 44
3. Ores treated in Colorado:				
Bayley & Sons, Golden City	231		25,675 00	
R. Pearce, Swansea	438		63,071 16	
A. Williams, Whale Mill	550		70,000 00	
N. P. Hill, Black Hawk	883		225,000 00	
		2,102		383,476 16
Grand total		5,421		1,204,761 06

Since the last yearly report there is but comparatively little change to be noted in the condition of mining affairs in Clear Creek County. But few sales of mining property have been made. The ore and bullion produced have been the product of a healthy industry, yielding a fair profit over all expenses; and this county can now be said to be self-supporting. The larger portion of the ore has been raised by men working under lease the property of others, and paying a fixed percentage of the gross product of the ore. This method, while it seldom permits the thorough development of the mine worked, has some advantages that are to be commended. The men working under the lease are directly interested in making the mine pay, and the expenses of management are very much lessened; great economy in working and full hours of labor necessarily follow. On the other hand the workings of the mine are generally done in too hurried a manner, only temporary timbering is used, and ore is mined out as fast as it is reached, without leaving any reserves to carry future workings through barren ground. A system of longer leases, with more thorough protection to the owner of the mine, would probably remedy this, and at the same time permit associations of miners to share in the profits of their own labor.

The market for the ore mined, up to the time of the late financial disturbance, was a fair one. Since that time, however, the price paid for ore has been low, and the market very irregular, only certain grades and kinds of ores being at all salable. Many of the miners are storing their ore, awaiting a better market. It is to be hoped that the present prices, which vary from 50 cents per ounce for 100-ounce ore to $1.05 per ounce for 1,000-ounce ore, will be only temporary, and that the capacity of the reducing-establishments in the county will be increased to an extent sufficient to treat at home all the ore mined in the county, thereby saving the heavy freight charges, commissions, profits, &c., which the shipment of ores to eastern and foreign smelting-establishments entails, and all of which are of necessity paid by the miner. The advantages of a home market for ores are so apparent that they need not be here noticed.

The past year has witnessed an unusual amount of mining litigation, which seems to be especially the curse of this section of Colorado. The profits of some of the best mines bid fair to be absorbed in legal fees, and Clear Creek County to be bankrupted by the expenses constantly arising from "jumping," and from the bloodshed which frequently follows. The prevention, so far as may be possible, of further litigation, and the speedy settlement of suits now in court, are matters which call for immediate attention and action from the legislature, and will be but briefly alluded to here. The adoption of a new mining-law, making the territorial law fully comply with the congressional law, and a change in some of the criminal laws of the Territory, will do much to prevent any further jumping of lodes, which too often results in loss of life. An enlargement of the jurisdiction and powers of the probate court will provide for a more speedy redress of grievances than is now available, and will also keep the docket of the district court free from cases of minor importance.

All of the older mines have been actively worked during the year, and have yielded well, while several new lodes, noticeably the Colorado Central, Welch, Polar Star, and others, have gained an enviable reputation for the amount and richness of ore mined. The lodes in the eastern end of the county have been worked to a considerable extent, and many of them have proved highly remunerative. The ore mined in that locality, which generally carries gold as well as silver, is nearly all shipped to the smelting-works of Prof. N. P. Hill, at Black Hawk, or sold to the smelting-works at Spanish Bar or Swansea in this county. These establishments have proved their ability to successfully treat the ores of Clear Creek County, have given general satisfaction to the miners, and therefore receive ore from all parts of the county.

The process employed is matte-smelting in reverberatory furnaces, the gold, silver, and copper contained in the ores being concentrated in the matte. When the necessary supply of iron pyrites cannot be obtained from the mines of Empire and the districts adjacent to Spanish Bar, the deficiency is supplied by shipments from Gilpin County.

The matte obtained has, up to a quite recent period, been shipped to Europe for further treatment; but since the successful establishment of the separating-works of Professor Hill at Black Hawk, it is probable that the matte produced in Clear Creek County will be treated there, and the gold and silver contained therein separated and shipped in fine bars, leaving the copper to be sent to market, either in the form of ingots or as sulphate, as may prove to be most profitable.

The amalgamating-works of the Stewart Silver-Reducing Company have been kept fully employed during the year, and have treated mostly second and third class ores from the Terrible and Pelican mines. Reverberatory furnaces are now used in this mill, the Stetefeldt and Arey furnaces, formerly used, having proved unfit for the perfect chlorination of the zincose and plumbiferous ores of this section. The amalgamation is performed in pans. The bullion, by the proper manipulation of the amalgam, is generally over .700 fine, and is shipped East without further refining. The inclined furnace, tested in the Crosby & Judd Mill, at Georgetown, during the past year, proved to be unfit for the work assigned to it, and the mill is now lying idle.

The old mill of the What Cheer Company, occupied by Huepeden & Co., Palmer, Nichols & Co., &c., situated in Georgetown, and containing two of Brückner's revolving cylinders, is now being refitted in a thorough and complete manner by Dr. Geo. C. Munson. The mill will be in operation early in the new year. It will have a capacity of at least 20 tons per week, and ought to do accurate work. The amalgamation will be done in barrels, and the silver shipped in the form of bars. The experience of past years goes to prove the Brückner cylinder to be admirably adapted for the roasting of argentiferous minerals.

The mill of Blackman & Co., at Masonville, twenty miles below Georgetown, has been in operation during a part of the year. The ore supply has been mostly obtained from the vicinity of Georgetown. The process employed is a chloridizing, roasting, and subsequent amalgamation.

The working results of the several amalgamating-mills, while not so perfect as those of the smelting-works, are yet highly satisfactory. The process is so well adapted for the treatment of the lower grades of ores mined in the vicinity of Georgetown, that it is hoped that other works will be erected, or that the now idle mill of Crosby & Judd will be supplied with proper furnaces and put to work. With the present capacity of the mills that will be in operation in January of the coming year, there is but little room for the treatment of ores other than those from one or two of the larger mines.

The Pelican and Terrible lodes alone can now more than keep all the mills supplied, leaving the Dives, Colorado Central, and other lodes that are producing largely, entirely without a market for their lower-grade (amalgamating) ores. The amount of this class of ore is large and is yearly increasing, and a steady supply can therefore be assured to all. It is to be hoped that increased milling facilities will be furnished during the coming year.

The subject of tunnels has been spoken of at length in previous reports. The tunnels of this county, as of other actively developed mining regions, comprise two classes: those driven to cut definite lodes, the value of which is more or less fully known, for the purposes of ventilation, drainage, and to facilitate the cheap and speedy extraction of ore; and prospecting tunnels, driven into the mountain for the purpose of exploring, at great depths, a given locality, and for the discovering of "blind" lodes. Tunnels of the first class, if located with judgment and driven with economy, may be perfectly legitimate mining enterprises. Of this class may be mentioned the Terrible and other tunnels in this county. Prospecting tunnels, on the other hand, must of necessity depend on chance for their profits. Of this class Clear Creek County has had more than enough. The Ocean Wave tunnel, which is driven on the Ocean Wave lode, belongs fairly to the first class mentioned; for while it is proposed to cut other veins, (the Ocean Wave being a cross-fissure,) the lode on which the tunnel is run is at the same time as cheaply and thoroughly developed by it as would be possible in any other way.

Work has been prosecuted with more or less vigor in the Burleigh, Marshall, Lebanon, Diamond, Eclipse, Hiawatha, and Douglas tunnels, in the last of which a lode carrying low-grade ores has been struck. The practical results of mining by cross-tunnels in this district have not been satisfactory; and while it is probable that some of the more advanced of the old tunnels will continue to be driven, it is to be hoped that no new ones will be inaugurated, at least for the present or until some of those now in operation prove remunerative.

Some placer-mining has been done this year, as in years past, on the bars and in the bed of Clear Creek, below the mouth of Fall River. These diggings were highly profitable in the early years of the settlement of the county, and employed many miners. The larger part of this year's work has been done in shallow ground, although several expensive shafts have been sunk to bed-rock, and drifting from that point has been commenced. The placer-mining industry of the country is slight, both as regards the number of men engaged and the area of ground containing placer-gold in paying quantities. This class of mining gives employment to a few men during the season, and yields in most cases nothing more than good wages for the time of actual operations.

As remarked in last year's report, the large part (nearly all, in fact) of the richer ores of Clear Creek County are treated outside county limits. In Georgetown there are several ore-buyers, doing a large business, and shipping many hundreds of tons of ore to points outside the Territory, and also to Black Hawk, Golden, and Denver. The ore is crushed, sampled, assayed, sacked, paid for in currency, and shipped at car-load rates to its destination, which during the past year has been mainly the smelting-works at Freiberg and Clausthal, in Germany. It is believed that but little ore has found an English market during the year. A number of car-loads of ore, rich in lead, have found a market in Wyandotte, Mich., where it is used to aid in the smelting of the rich silver-ores from Silver Islet. Much was expected from the smelting-works established at Denver during the past year, and it was hoped that they would furnish a remunerative home-market for such of our ores (particularly those carrying a fair percentage of lead) as were not treated within the county. These expectations have not yet been realized, and the practical working results of the Denver Smelting-Works have, up to the present date, afforded Clear Creek County no encouragement to hope for the market which the county needs. Doubtless the experiment will be renewed hereafter under better conditions. Denver being a central point for the northern mines of Colorado, and being connected by railroads with the principal coal-fields of the Territory, is the proper point for the treatment of such ores as cannot be economically treated in the immediate vicinity of the mines. The question of a metallurgical fuel is highly important. Recent experiments go to prove that the Trinidad coal can be coked. If the practical results of the coking furnaces should be satisfactory, there can be no doubt but that the substitution of such coke for charcoal in the lead blast-furnaces will have a very potent influence in cheapening that method of reduction.

The smelting-works at Golden have bought a small quantity of Clear Creek County ores, more particularly those carrying a heavy percentage of lead, and have, as far as is known, done good work. The establishment, however, is too small to afford any great relief to the miners of the county, who need a steady market at fixed prices, and one that a few weeks of mining will not overstock with ore. There are a number of lodes in the county, more particularly in Argentine district and in the country adjacent to Mill City, that carry galena-ores, containing a high percentage of lead, and from 10 to 50 ounces per ton in silver. There is at present no market for this character and grade of ore, and no encouragement, therefore, for the developing of such mines. The lodes carrying the ores described are usually of good width, and are characterized by large bodies of mineral, and their development and working would give employment to a great number of miners.

Some attention has been directed during the past year toward the proper concentration of the ores of the county. It is very evident that, while certain grades and kinds of Clear Creek County ores do not need concentration prior to smelting or to a chloridizing treatment, yet there is a large portion of the ores which are brought to the surface that could be cheaply and thoroughly concentrated without any excessive loss resulting from the machinery employed. There is not a mine in the county now worked that does not furnish more or less material containing valuable minerals, so mixed with gangue as to preclude any attempt at hand-dressing. This is particularly the case in the largest and best-known of the mines, and the attempt of the Terrible Company to dress its lower grades of rock at and below the mine is therefore to be viewed with special satisfaction. During the past summer this company has handled 1,568 tons of crude material, and produced therefrom 167 tons 1,053 pounds of marketable ore. The crude ore, concentrated at a cost of $4,398.25, (being $2.80½ per ton,) has yielded $24,683.06 from material that was practically worthless before treatment, and the tailings average only four ounces per ton. Other mines are preparing to erect jigs, &c., in which to concentrate their lower grades of rock. Some lodes, particularly the Pelican and Colorado Central, have immense bodies of gangue, in which is mixed ore in small streaks and spots, and which is, therefore, well adapted for concentration by means of water. In the Empire district there are numerous lodes, carrying iron and copper pyrites, (argentiferous as well as auriferous,) mixed with gangue, and well adapted for concentration. A large portion of this class of ore could be passed through a stamp-mill, and some of the gold contained in it could be thus saved. Proper concentration of the tailings would yield a readily salable product.

The concentration-works of Mr. John Cullom, near Idaho, have been finished and put in operation during the past summer. The practical working results of these works are not yet known. There is an abundant supply of material for such an establishment to be obtained from the lodes in the vicinity.

The mill of Frederick Schuchardt & Sons, in Empire, is provided with several of Hendy's concentrators, taking the pulp from the stamps. These machines have not proved successful, and are not now in use. They are in use in the mill of the Stewart Silver-Reducing Company, where they receive the pulp after amalgamation, and after being passed through settlers. A part of the imperfectly-roasted portion of the ore is caught by them and saved for further treatment.

The works of Dr. J. G. Pohle, at the Lebanon Mill, near Georgetown, contain two jigs. An engine is now being erected there, and work will be carried on during the winter. The works have been experimenting on the different kinds of ores; but the results are not yet known.

The Wilson & Cass Mill, just below the town of Georgetown, is still idle. The mill is a large one, and has every appliance for the successful concentration of ores by water. The capacity is about 40 tons per day. It has never been in successful operation.

Considerable work has been done in Empire during the past year. Dr. George C. Munson, agent of Messrs. Frederick Schuchardt & Sons, of New York, has been working the Tenth Legion lode during the entire year. The lode is a good one and contains large bodies of iron pyrites, carrying both gold and silver, but the excessive subdivision of the vein among many owners renders profitable mining very difficult, if not entirely impracticable. The ores are sorted into two classes, smelting-ore, and stamp-mill rock. The smelting-ore is sold to the Swansea Works, where it finds a ready market, and where it is converted, together with rich silver-ores, into iron and copper matte. The stamp-mill ore is passed through the mill belonging to the mine, the tailings having been imperfectly concentrated for a short time, and sold to the works above named. Lately the tailings have been permitted to go to waste. The Tenth Legion is a strong vein, and if the various owners of it could be made to consolidate their interests, so that the mine could be properly opened, it would furnish a large amount of good ore. The Conqueror tunnel, designed to cut the Conqueror lode at a very considerable depth, is fast approaching completion. This tunnel will drain the mine, and permit its being worked cheaply. The Conqueror lode in past years furnished a large amount of good stamp-mill ore, and its further working, it is hoped with good reason, will prove remunerative, particularly as the large amount of water which the mine formerly collected will now soon be removed by the tunnel.

Work has lately been commenced on the Cashier lode, in Empire, and a tunnel will be driven in on the vein. This lode furnishes a good grade of iron and copper pyrites, carrying from three to six ounces of gold per ton, and will probably prove a valuable aid in furnishing the large amount of such ores desired by the two smelting-works in the eastern end of the county.

Since the late financial crisis, some attention has been directed toward the establishment of a coinage department in the United States mint at Denver, and petitions to Congress praying for the establishment of such a department have been extensively circulated and signed. There can be no doubt but that if the Denver mint be made a mint for coinage, the effect would be felt throughout the Territory, and a large proportion of the gold and silver that is now sent East as fine bullion would be retained here in the form of coin. The effect on the ore-market of Clear Creek County would be very great, and the price for ores could be regulated by a fixed standard of value—and the sudden and ruinous changes and depreciations, such as have lately taken place, would not be again possible. The amount of bullion suitable for immediate coinage is yearly increasing and will now continue so to do, particularly if coin can be had for gold bullion and silver bars. This bullion is now subjected to heavy express and other charges if it is sent East, and the return currency is also subjected to heavy charges. The item of exchange is a serious one in the Territory—and this, as far as mills and many of the mines are concerned, would be done away with by coinage in the Territory. A certain degree of benefit would accrue to the Territory by the adoption of the system (as is proposed) of giving coin certificates for bullion deposits in the Denver mint. This will not be as well as the coinage department, for the reason that these certificates will simply act as eastern exchange and not as a circulating medium, which is what is desired for this Territory. The premium on gold is now low and is not liable to go higher, and gold and silver coin would be almost certain to remain in the Territory and serve as a medium for the transaction of business—where it would be welcome, particularly in the mining camps. Ores would then have a fixed value, and be not subject to the effects of eastern speculations or Wall-street troubles.*

The number of mines actively and profitably worked in this county during the year has been larger, and the number of tons of ore produced is greater, than during any previous year.

In Argentine the principal mines worked were the Stevens, Baker, Timber Line, Lion, and Belmont. The Stevens has been unusually productive and has yielded about 200 tons of a high-grade lead-ore carrying about 125 ounces in silver per ton and 50 per cent. lead. This ore has been almost entirely sent out of the county for treatment.

On the north face of Leavenworth Mountain is the Pulaski, a vein carrying mainly iron pyrites, noted for its value in gold. Specimens assay as high as 9 ounces in gold per ton, and the mill-runs have been as high as 3 ounces gold with from 30 to 60 ounces in silver. This is a remarkable ore for this locality.

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*I have suffered Mr. Stoelting's remarks on the subject of coinage at Denver to remain unaltered, lest by substituting my own views I might render him liable to misconstruction at home. I do not agree with him that the actual manufacture of coins at Denver is requisite in order to secure the practical conveniences desired. Nor do I think it wise to multiply mints for coinage. There is none at New York; and if the Denver assay-office were empowered to pay coin for bullion (as the New York assay-office is) the Territory would be quite unconscious and indifferent as to the place where the coin was manufactured.—R. W. R.

On the southeastern slope of Leavenworth are the Colorado Central, Equator, Saco, Star, Gates, Welch, Cross, John Bull, Ni-Wott, Magnolia, Gilpin, Homestake, and Argentine lodes. The last-mentioned lode carries a pure galena, with from 30 to 250 ounces in silver per ton. The Gates, now under active development, is located in the vicinity of the rich belt of lodes that have made Leavenworth Mountain famous. The ore is galena, zincblende, and a very rich gray copper. About twenty-five men are employed in the mine, and this force is being increased as rapidly as the opening of the mine allows. This lode bids fair to take rank with the Colorado Central and other famous lodes of that locality. This part of the district has furnished the larger part of the high-grade shipping ores sent abroad for treatment. The average value of these ores is not only high, but the quantity furnished is at the same time large.

On Brown Mountain the Atlantic, Shively, Brick Pomeroy, Baltimore Tunnel lode, Seven-thirty, Hercules, Benton, Roe, Old Missouri, Coin, Brown, Mammoth, Terrible, Silver Ore, Glasgow, and Gunboat have been worked during the season. The Baltimore Tunnel lode has furnished a number of tons of very high-grade ore, carrying silver glance and gray copper, as well as the more common ores of the vicinity. The Seven-thirty and Hercules have been constantly worked during the year, and have furnished a large amount of rich ore. The ores from Brown Mountain are mostly "heavy" ores, carrying galena and zincblende.

On Sherman and Republican Mountains the Bismarck, Saint Joe, Denver, Maine and Phœnix, Scotia, Corry City, Pelican, Dives, Pay-Rock, Hopewell, and Silver Plume have been in operation during the year. The lawsuits between the Maine and Phœnix titles have been in the courts during the entire year, and have very materially interfered with the proper and continuous workings of those lodes. The Pelican and Dives have both furnished a large amount of ore. Connection has been made in the underground workings of these lodes, and if a compromise it not effected the law will be called upon to settle the title of the property. If once consolidated this would be the best property in this section of Colorado if not in the whole Territory.

On Democrat Mountain the Polar Star, Rodgers, Lucky, and Junction lodes have been in constant operation. The Polar Star is remarkable for the large amount of native silver it carries, and this is true to a limited extent of other lodes in the same vicinity. The ore furnished is generally of high grade.

In the eastern end of the county the Hiawatha, Hukill, Edgar, Seaton, Veto, Fairmount, Crystal, Clifton, and other lodes, have been actively worked during the year. The Hukill is probably the best of these lodes, having a large crevice, with an unusually good pay-streak of ore. The mineral, iron and copper pyrites, with some galena and zincblende, carries both gold and silver, and finds a ready market at the several smelting-works in the county and at Hill's, in Black Hawk. The Seaton and Veto, and other lodes in that vicinity, carry also gold in small quantities, and yield a large amount of ore. The Fairmount and Edgar are worked on lease, and furnish ore of good grade, averaging over 3 ounces in gold per ton. The lodes in this section of Clear Creek County carry generally both gold and silver, and while the ore is not as rich as in the vicinity of Georgetown, it is found in larger quantities.

The general progress throughout the county has been satisfactory, and the prospects for the coming year are highly favorable. The county is entirely self-supporting, and is also paying a fair return to nearly all the later investments that have been made in mines within the county limits.

Appended hereto will be found a brief statement of a few of the more prominent mines.

Pelican: This lode, situated on Sherman Mountain, about 750 feet above the level of Clear Creek, and two and a half miles from Georgetown, is probably the most prominent vein now being worked in this vicinity. The lode strikes nearly east and west, and dips slightly north. It has a gneiss country rock, and wherever exposed, good walls are found. The width of the vein has not been fully determined, and it is almost certain that the so-called Zephyr, Elkhorn, Zillah, and Pelican lodes are ore-veins in one and the same fissure. This being the case, the width of the lode is not less than 50 feet in Cherokee Gulch, and about 25 feet where the Elkhorn and Pelican come together, 400 feet west of tunnel No. 1. The Pelican ore-vein is on the hanging (north) wall, and the Elkhorn on the foot-wall of the crevice. The gangue is a more or less intimate mixture of feldspar and quartz, which in the lower workings sometimes shows a porphyritic appearance.

The developments are: First, an adit level run on the vein from Cherokee Gulch, a distance of about 500 feet. Stopes have been carried above this level, and great quantities of very rich ore are taken out. Second, the Eagle Bird level, 500 feet in length, connected with the surface by a cross cut tunnel, (tunnel No. 1.) This tunnel is about 100 feet long. At 70 feet from the mouth it cut the Zillah on Elkhorn lode, on which a 20-foot level was run, and a shaft sunk, connecting with the Pelican level, 80 feet below. Third, the Zillah or Elkhorn level, about 30 feet deeper than the Eagle Bird level, and 400 feet in length. Fourth, the Pelican level, 50 feet below the Zillah level and 480 feet long. This level is connected with the surface by tunnel No. 2, which is 324 feet in length. From this level, at a distance of 80 feet west from the tunnel, a shaft is being sunk, (now 83 feet deep,) and at 60 feet deep drifts have been run east and west. About 70 feet east from the tunnel a shaft (now 115 feet deep) is being sunk, and will be continued to the level of tunnel No. 2½. This is to be the main working-shaft. It is 12 feet long by 8 feet wide, and is provided with a horse-whim. At 60 feet deep in this shaft drifts have been run east and west. The west drift has been connected with the east drift from the west shaft and stoping commenced. The levels are connected by the necessary winzes and shafts, securing good ventilation and affording means of bringing ore from the upper levels to tunnel No. 2, and thence, by tram, to the surface. Two more cross-cut tunnels are being driven to cut the vein at 200 and 400 feet deeper than tunnel No. 2. Tunnel No. 2½ is completed to a distance of about 305 feet, and tunnel No. 3 to a distance of 150 feet. They will be, respectively, 600 and 900 feet in length. No stoping has been done, with the exception of a small amount above the adit-level and on the ore-veins called Zillah and Elkhorn.

The ore-chimneys have a strong inclination to the east. It is impossible to give their lengths, as none of the workings have yet been driven to their eastern boundaries. The main chimney is in the eastern workings, with several smaller chimneys between it and the one developed in the extreme western end of the Zillah level. The pay-streak varies in width from a few inches to 5 feet and more in places, with immense bodies of material carrying from 15 to 35 ounces of silver per ton. The ore is more or less intimate mixture of zincblende, galena, iron pyrites, gray copper, and other rarer silver-ores, such as stromeyerite and polybasite, ruby silver, and silver glance. The ore occurs in solid veins of from 6 inches to 5 feet in width, with smaller seams and bunches through the gangue. It is hand-dressed into—

First class..........	350 to 500 ounces per ton, (sometimes 850 ounces.)
Second class........	125 to 150 ounces.
Third class..... ...	35 to 50 ounces.

At present the ore is shipped to the amalgamating-works just as it comes from the mine in bulk, and in this condition it averages about 160 ounces per ton in silver.

The main chimney, as developed in the Eagle Bird level, commences at a point about 300 feet west of tunnel No. 1, and extends east the whole length of the level, showing an ore-vein of from 1 to 6 inches of solid mineral, and from 1 to 2 feet of second-class ore. The further development of the same chimney in the Pelican level shows the ore-vein to commence at a point 125 feet west of tunnel No. 2, although there is more or less ore to be seen nearly the whole length of the level. The ore-vein increases in width as it is developed to the east, until it reaches in the extreme eastern end of this level, where the main shaft is being sunk, a width of 3 feet of solid mineral and a proportionate amount of second-class ore. Nearly the whole gangue matter at this point carries from 15 to 35 ounces in silver per ton. The third-class ore at this point is about 30 feet in width and will pay well for concentration.

The main shaft, which is being sunk here, shows a larger body of ore than any other portion of the mine. The full width of the shaft, 8 feet, is in first and second class ore; while in the drifts being driven from this shaft at a depth of 60 feet both east and west, the solid mineral is from 2 to 4 feet, and the second-class ore from 2 to 6 feet in width. The ore-vein seems to improve in this east drift, now 125 feet long. One place near the present terminus of this drift has fully 5 feet of solid mineral.

The ore-vein called the Zillah lode is developed by the Zillah level, over 400 feet in length, showing an ore-vein of from 1 inch to 6 and 12 inches. The average width may be safely put at 8 inches. In some places pockets 4 feet in width have been found. According to actual measurement about 1,400 fathoms of ground have been worked out in drifts, shafts, and stopes. The ore from this ground has yielded a gross sum of $664,303, with $50,000 worth on the dump. Mining expenses have been $224,434, leaving a net profit of $439,869. The number of men employed averages about 70, of whom 30 have been taking out ore.

All the above figures are up to October 1, 1873. Careful measurements at that time gave 4,400 fathoms of ground exposed. Deducting one-fourth, we have 3,300 fathoms of rich ground, the gross yield of which will be about $1,683,660.

Terrible lode: This mine, which was among the first to gain reputation in the district, is situated on Brown Gulch, 600 feet above Brownville. The main location is owned and worked by an English company, and the eastern end by an American company. The lode has an east and west course and dips 27° north. The width of the vein between walls is not definitely known. The ore-vein averages through the whole mine 4 to 5 inches, with frequent places 12 to 15 inches wide. At the tunnel-crossing the gangue is 22 feet in width, with no north wall found. Smaller streaks are intermixed through the gangue. The mineral consists of galena, zincblende, and pyrites, with ruby-silver, gray copper, native silver, polybasite, &c., the zincblende predominating. The lode is developed to a depth of 440 feet from the surface, and 400 feet west and 300 feet east from the tunnel, which cuts the lode at a depth of 300 feet. About two years' stoping-ground is exposed. The ore-shoot pitches west. The mine has produced in the past year ore to the value of about $115,000, (coin,) the larger part of which has been shipped to England. The ore as mined is brought to the surface through the tunnel, and is there hand-sorted to a certain extent. The third-class material, after washing, is sent by an iron cable tramway to the foot of the hill, where it is jigged and separated into several grades, one of which (the iron pyrites) carries from 1 to 1½ ounces of gold per ton. There are now on hand about 3,000 tons of third-class rock, which will be concentrated during the coming summer in the concentrating-works now in process of erection. The richness of the ore has increased as depth has been gained, and is now nearly double what it was in the surface-workings. Since the commencement of operations by the English company in May, 1870, the total yield of the mine has been $366,175. The average number of men employed in the mine during the year has been 28, in addition to which a number of men have been engaged in jigging ore, &c. There are now twenty men opening ground and fourteen back-stoping.

Colorado Central: This lode, which was discovered late in the year 1872, by W. P. Linn, is in the immediate vicinity of the Equator lode, on Leavenworth Mountain. The Marshall tunnel had previously cut the vein, (known as tunnel lode No. 5,) but had not done anything toward its development. The lode is opened on the surface by the Discovery or Weaver shaft, the McCoy, Shea, and Reed shafts. It is of an enormous size, being in the Weaver shaft more than 70 feet, cross-cuts having been run to that distance without reaching any walls. Where cut by the Marshall tunnel the lode is 22 feet in width. The ore occurs in irregular pockets and streaks throughout the whole gangue-mass, and consists mainly of galena and zincblende, with occasional streaks of gray copper, often as wide as 3 inches, and carrying as high as 40 per cent. of silver. Streaks of silver glance 1½ inches in thickness have been found. In the Weaver Discovery shaft the solid rock was struck at a depth of 40 feet, and very rich ore was struck not only in the bed-rock, but also in the vein immediately where struck. This pocket extends along the vein about 200 feet, and has furnished a large amount of very rich ore. Considerable work has been done in the way of opening the lode at lower depths, and a number of ore-veins have been there exposed. Yet the product of this pocket alone during the year 1873 (to December 15) was 247½ tons, with an aggregate value of 84,589 ounces of silver, being an average of 347½ ounces per ton. The first-class ore mills from 800 to 1,600 ounces per ton, the second class from 200 to 600 ounces, the third class from 66 to 175 ounces, and selected ore from 2,570 to 4,225 ounces per ton. The McCoy shaft is 200 feet east of the Discovery shaft, and is on the ground of the Marshall Mining Company. The shaft passes 45 feet through "slide," and then 155 feet on the vein. A cross-cut tunnel, known as the Robinson tunnel, cuts the lode at a depth of 114 feet. In order to facilitate mining, a shaft 300 feet in depth is being raised from the Marshall tunnel, (now lacking but 35 feet of completion.) Drifts will be run every 60 feet after connection is made between the Robinson tunnel level and the Marshall tunnel. This part of the mine has produced about 225 tons of ore, with an average assay value of 270 ounces, for which $71,000 in currency was received. The Shea shaft is 170 feet west of the discovery shaft. It is 50 feet deep, and has produced some ore. The Reed shaft, 300 feet west of the Shea shaft and 100 feet deep, had reached, up to the end of the year, no pay-rock.

The Coldstream: This mine is on the Maine lode, and has been described in former reports as the Maine. Mr. Glenn, the proprietor, has been much impeded in his operations by the unfortunate litigation with the owners of the Phœnix, into the merits of which I do not care to enter here. The Coldstream mine was, by the most recent accounts, looking uncommonly well. The Maine lode, as shown in the upper level of the mine, has a very regular course of about north 68° west true, and a uniform dip of 45° north, as observed at numerous points in the mine. Near the surface this dip is smaller, that is, more nearly horizontal. The north or hanging wall is distinctly defined; but on the other side the vein gradually disappears in the foot-wall, without a distinct line of separation. The country-rock is gneiss, sometimes altered into quartzite, (locally termed porphyry,) and coursing nearly northwest and southeast. The vein carries ore everywhere, "frozen," or firmly united to the hanging-wall, without clay partings or selvages, and varying in width from a few inches to 3 feet and upward in the wider places. It is developed by several shafts, adits, cross-cuts, &c., many of which have been located for prospecting purposes, or for their bearing on the disputed title. Some have never reached the lode, and only serve to demonstrate where it is not; others have reached it by virtue of desperate and tortuous cross-cutting. At the bottom of the discovery-shaft, 65 feet deep, the ore is 8 to 10 inches wide, and continues 25 feet east of the shaft, the different classes assaying respectively 88, 117, 132, and 204 ounces silver per ton. The mineral is mainly galena and zincblende, the latter often predominating. West of the discovery the vein is opened for 225 feet,* by a level. At 70 feet west, a large pocket of low-grade ore 3 to 5 feet thick, was struck. At 125 feet west another pocket, 10 inches to 2 feet thick, was passed through. Assays gave 150 to 800 ounces per ton; and 50 feet farther west the level entered a pocket 1 to 6 feet thick and 40 feet in horizontal length, assaying 88 to 732 ounces per ton. The ore in this level has been very zincose, carrying an average of 25 per cent. of zinc. On the second level from the bottom of the Discovery shaft, about 260 feet of drifting has been done, and this work is still going on east and west in ore. The main shaft is progressing downward, and 120 feet west of it a winze is being sunk to open level No. 3, 65 feet below No. 2. I believe the litigation, which is still in progress, has prevented stoping, or, at least, the sale of ore.

BOULDER COUNTY.

The mining industry of this county has advanced materially during the last year. The older camps have advanced steadily and many new discoveries have been made.

I have been favored with the report of Mr. Lawrence Thompson, territorial assayer, at Boulder City; and the following is mainly from his pen.

In gold and silver mining throughout Boulder County, and the adjacent mineral region northward, greater progress has been made than during any preceding year. This decidedly favorable change may be attributed in part to the profitable operation of mines which had previously been opened, and in part to the beneficial influence of the change made in the mining laws by the last Congress, tending to make available abandoned claims and to encourage the application for patents on mining locations—thus settling titles and recalling old claimants to neglected properties.

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* These figures, obtained in the early spring of 1874, are here substituted, during the publication of this volume, for those which I gained by a personal examination of the mine in June, 1873.—R. W. R.

Among the events meriting special mention is the establishment of the mining camp known as Sunnyside, near the head-waters of the Four-Mile Creek, in Boulder County, in the center of a cluster of lodes yielding free gold-ores, not till this year known to exist in that section, which promise to add much to the bullion product of the county. Much exploration has also been done along the eastern base of the mountain-range, overlooking the Boulder Valley, from Cariboo northward. Some valuable discoveries, especially of rich galena-ores, have been the result. A number of roads are being constructed to make these high and remote sections accessible to mining enterprise. Also, northward from Ward district, toward the South Fork of the Saint Vrain Creek, the mining area is gradually extending. Much prospecting has been done, and many newly discovered veins of gold and silver are opened in the older mining districts of Boulder County, particularly on Gold Hill, and in the Four-Mile district, greatly stimulating mining and raising the value of property in those sections. A number of metals have been discovered in various combinations, which heretofore were not known to exist in the county. Bismuth has been found in combination with silver, in the Los Animas lode, Four-Mile district, twelve miles westerly from the town of Boulder, and indications of its presence exist in other veins in the vicinity. Within the year tellurium, combined with silver and gold, forming the richest ores of the precious metals known in nature, has also been found in a number of mines besides the Red Cloud on Gold Hill, where its presence was first made known. The belt of tellurium-bearing veins is found to extend from the Gray Eagle lode on the north side of Left-Hand Creek, in a southerly direction over Gold Hill to the Forrest mine on Four-Mile Creek. As the result of the profitable working of the mines in this part of the country, the year shows an increase in the production of ore. The additional machinery now being erected and nearly completed at the Cariboo Silver Mill at Middle Boulder, doubles its capacity, making it 36 tons per day.

A new gold-mill has been established in the Sunnyside district.

At the Chlorination Works, on the Ni-Wot Hill, in Ward district, successful tests of the adaptation of the Plattner process for the treatment of the sulphuret ores, characteristic of the mines in that section, have been made.

Arrangements are perfected and material is being put on the ground for the erection, early next season, of smelting-works near the town of Boulder for the treatment of the gold and silver ores of the tributary regions.

Gulch and placer mining is conducted more systematically and according to better methods than heretofore, and has consequently been enlarged and successfully prosecuted during the past season. The bed of the Four-Mile Creek has been claimed for mining purposes all the way from its mouth to its source, and to facilitate washing it for gold an expensive ditch, three miles in length, has been constructed to turn the water of the North Boulder Creek into the first-named stream. Another important mining-ditch has been made, extending from the South Fork of the Saint Vrain across the Left-Hand Creek, and thence, by a canal formerly constructed, to Gold Hill. It is designed to provide an ample supply of water for use in the gulch and placer mining of Gold Run and vicinity. It is quite impossible to obtain accurate accounts of the amount of gold washed from the bed of creeks and placer-workings, since so large a part remains in private hands or is sent east by private conveyance. Moreover, many parties operating in both gulch and lode mining, from motives of policy or delicacy about disclosing matters of private finance, are reluctant to communicate the information desired.

Within the year gold and silver ores from Boulder County have been shipped to a limited extent, some to the ore-markets of foreign countries, some to the furnaces of the East, some to the reduction-works of Denver, Golden, and Black Hawk. But the bulk of the Boulder County ores has been worked in home mills, in the Cariboo Silver Mill, or in the mills used for the treatment of the free gold-ores situated farther north. These ores worked at home and abroad are mostly the result of operations in mines of established value conducted for profit; but in some instances ores sent to market are designed simply to test the value of the rock in bulk as the work of development progresses.

In Grand Island district the Cariboo mine has been sold to a Dutch company for a very high price, in which the mill at Middle Boulder was included. New developments in depth in the Cariboo are favorable. A tunnel is being run on the north slope of the mountain, to tap the vein. Of other mines, in which good ore has been regularly found, the Sherman and No-Name are the principal ones. In the latter an extremely rich chimney of native silver and chloride of silver has been discovered, and at last accounts the mine was in the market at a high price.

The total product of Boulder County for 1873 was about $390,000.

SUMMIT COUNTY.

Since my last report there has been but little change in mining affairs in this county. The various placer mines of the county continue to be worked, but with a slightly diminished force as compared with the previous year. An increased interest in lode-mining is to be noticed, and a considerable amount of prospecting has been done in various parts of the county.

The erection of a smelting-furnace in French Gulch has turned some attention towards the galena lodes in the vicinity of French and Illinois Gulches. If the operations of the furnace prove successful, and a demand for galena-ores springs up, there is no reasonable doubt that the large lodes of such ores already known to exist in that locality could be worked with profit, furnishing winter employment for the placer miners.

The season has been only a moderately good one for the county. The practice of booming* has permitted the successful working of poorer ground than has been before worked in the county.

The large ditch of Fuller & Co., to carry the water of the South Swan to the Georgia Gulch country, is as yet unfinished, and a large amount of ground, that will yield a fair revenue with a proper supply of water, remains unworked. The population of the county does not exceed 350, the larger part of whom are engaged in placer-mining.

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* A rude form of hydraulic mining, in which a torrent of water, obtained by the accumulation of smaller supplies, is suffered to escape from the reservoir at intervals. Details of the arrangement of gates, &c., are given below.—R. W. R.

The production of the county for the past year has been as follows:

Placer gold, going to Denver	$75,000
Placer gold, going north to Union Pacific Railroad*	26,000
Ores sold	5,000
	106,000

The different placer claims in the county, more fully described in last year's report, will be briefly reviewed.

On the Upper Blue River and in Hoosier Gulch, Bemrose & Co. and others have mined during the short season, (the altitude being over 9,500 feet above sea level and the supply of water scanty,) and have realized remunerative returns.

Next below, and about two miles above (south of) Breckenridge, is the claim of Mr. McLeod, which has been worked to a slight extent during the summer. Below the McLeod claim is the ground owned and worked by Fuller & Crome. This claim is on a Blue River bar, the bed-rock is comparatively shallow, and the pay good. Messrs. Fuller & Crome work four men during the season, and during the low water of the fall months work in the bed of the river. Silver nuggets are found in this part of the Blue River, some of which have weighed as much as 1½ ounces. Immediately west of Breckenridge is the booming claim of Messrs. Jones & Greenleaf. This claim employs two men, with good results, in ground that previous to the introduction of the booming process could not be successfully worked. Below Breckenridge and on the west side of the Blue River is Iowa Gulch, owned by Adams & Twibell. This is also a booming claim, and one that has yielded well. Under the old system of working the ground scarcely paid expenses. Two men are employed. Just above the mouth of Ten-Mile Creek, ground is being opened by Izzard & Co., but no returns will be realized until next year. Below the mouth of Ten Mile, and emptying into Blue River, is Salt Lick Gulch, which employs four men during a season, which is longer than the rest of the county usually enjoys. The ground is good and water abundant. The yield during the past season has been about ½ ounce of gold per day per man. On the east side of the Blue, and immediately above Snake River, are Soda Gulch and its tributaries. This ground yields at least $5 a day to the hand, but is sadly in need of more water. There is a very considerable area of side-hill ground around this gulch which would pay well for booming, if water was brought to it.

The Springfield Mining Company, working on the east side of the Blue River, just below Breckenridge, is running two flumes, and employs four men. The pay is good.

In French Gulch, about the same amount of mining has been done as in former years. In the upper part of the gulch, Cobb & Co. are running six flumes, employing twenty-four men. The ground is somewhat spotted, but where pay is found, it is rich.

Calvin Clark, next below, is running a flume in the gulch and also a boom on the side-hill, in both of which he has good pay. Water is somewhat scarce.

The McFarland claim, next below, has been worked during a part of the summer, and has yielded about ½ ounce per day to the man. If work had been commenced during the flush of the water, in the early summer, the returns would have been much larger. The ground of the Badger Company (a Denver organization) comes next. Bed-rock has been struck in this claim at a depth of 25 feet, and good pay found.

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*This is the product of new diggings at the base of Hauser's Peaks, in the extreme northeastern part of the county, near the Wyoming line. The total product of the county is given by the Georgetown Mining Review (good authority) at $111,000; but, with the concurence of the editor, Mr. Van Wagener, I have transferred $5,000, the product of the Gunnison River diggings, from this county to Lake County, where, according to Hollister's map, these diggings lie.—R. W. R.

In Nigger Gulch, a tributary of French Gulch, a boom has been in running order for a short time during the season. Ten men have been employed, with fair results.

On Stilson's Patch, on the west side of French Gulch, Messrs. Sissler & Mower and Mr. Hangs have been working, by the hydraulic method, and realizing about $6 a day to the hand. Next below is the ground of the Blue River Mining Company, employing six men, and in good pay.

Immediately below, and at the mouth of French Gulch, is the General Grant flume, employing four men and yielding about $6 a day to the man.

In Georgia Gulch, Mr. Hitchcock and Messrs. Iverson & Furth are working on good pay. Eli Young & Co. are running a bed-rock flume up the Swan River, with the intention of reaching bed-rock below the mouth of Georgia Gulch. This is a good enterprise, and has been steadily prosecuted for several years. Bed-rock has not yet been reached, although the ground now pays expenses. It is highly probable that this flume will develop some exceedingly rich ground, as it will drain the mouth of Georgia Gulch, once the richest placer-field in the county.

In Galena Gulch, Messrs. Riland and Twibell & Co. are mining with fair results. Between Delaware Flats and Galena Gulch is Strogsdale's Patch, owned and worked by Strogsdale and Twibell. This is the best placer-ground in the county. The yield will average fully 1 ounce per day to the man. Five men were employed during the past season.

A. Delaine, at Delaware Flats, has employed three men during the season, and realized about ½ ounce per day to the man.

In Gold Run mining has been steadily carried on during the season.

Walker & Majors have employed three men, the pay being ½ ounce a day to the man. Moffat & Canfield, three men; pay, $7 a day. L. Peabody, six men; pay, $7 a day. Tiffin Mining Company, five men; pay fair. J. Nolan, three men; pay fair. G. Mumford, five men; pay, $7 a day.

Booming.—This method of mining poor placer-ground is rapidly coming into favor in Summit County. In Mayo, Nigger, Lomax, and Iowa Gulches mining is carried on in this manner with remunerative results, and it is highly probable that other localities will also adopt this process. The introduction of the "self-acting gate," whereby the opening and shutting of the gate of the reservior is made automatic, leaves scarcely any further economy to be introduced into this method of mining. The self-acting gate now considered the best, consists of a water-box suspended in guides, the rope from which passes over two pulleys, one of 12 feet and one of 5 feet, to the lower edge of the canvas gate, (barred with strips of iron or 2-inch timber.) When the water in the reservoir reaches the proper height, a small flume conducts it to the box, which, when full of water, has weight enough to roll up the canvas gate at the bottom of the reservoir from the bottom, allowing the water in the reservoir to issue through a gate, (generally 4 by 6 feet in size.) By the time the reservoir is nearly empty, the water in the weight-box has discharged itself through holes made for that purpose in the bottom, and a weighted arm on the second pulley drops the gate to its place, where the pressure of the water in the reservoir keeps it in place, water-tight. One man is now considered ample force to run a boom, and his duties consist mostly in clearing timber from the ground to be worked, and in breaking the larger bowlders into sizes small enough to go through the flume, which is usually 4 feet wide, with a grade of 1 foot in 12. The use of a boom permits the working of ground that could by no other means be made to pay. The experience of the Summit County miners goes to prove that, notwithstanding the large amount of water used, and the velocity with which it rushes through the flume, the gold collects readily in the upper boxes of the flume, in which mercury is generally placed. Booming may be considered as the best labor-saving invention introduced into the country of late years, and while it is not adapted to all placer-claims, it permits the working of claims that would otherwise be valueless. The following diagram illustrates the contrivance:

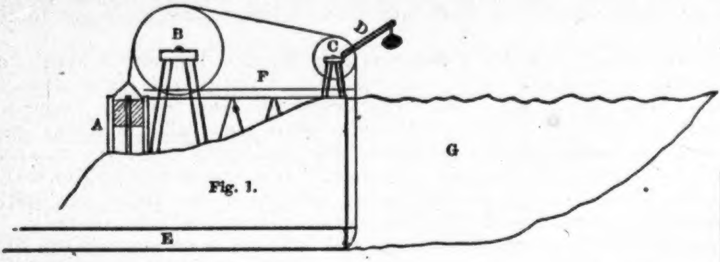

Fig. 1.

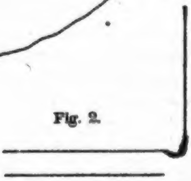

Fig. 2.

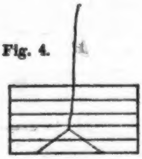

Fig. 4.

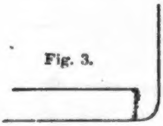

Fig. 3.

Fig. 1. Sectional view.
A. Water-box.
B. First pulley.
C. Second pulley.
D. Weighted arm.
E. Flume.
F. Water-flume to water-box.
G. Reservoir.
H. Gate.
Fig. 2. Gate open.
Fig. 3. Gate closed.
Fig. 4. Gate closed. Front view.

Lode-mining.—Aside from the work done in the Snake River mines, but little lode-mining has been done. The Vanderbilt, a free-gold quartz lode in the quartzite on the Upper Blue, has been worked a little but no ore has been treated. Arrastras will probably be erected during the coming year. The ore is rich and of a character easily treated, and good working results are therefore to be expected. The Hunter, east of Hoosier Gulch, has been worked during a part of the summer. The ore is of good quality, and will mill about 200 ounces in silver per ton.

The Cincinnati lode, on Mineral Hill, French Gulch, has been opened by Messrs. Sears & Conant. The lode has been traced for about 900 feet on the surface, and the deepest shaft is now about 40 feet. Two hundred tons of mineral are on the various dumps, and the ore-vein, wherever opened, shows from 2 to 16 inches. The ore is a clean, coarse galena, free from zinc, and carries from 30 to 40 ounces of silver per ton. A reverberatory furnace has been erected in French Gulch, and a few pigs of lead have been made. It is proposed to erect a shaft-furnace for the treatment of this and ores from neighboring lodes.

Some work has been done on lodes around the head of Illinois Gulch. The ore is generally a pure galena, mixed with sulphate and carbonate of lead, assaying from 40 to 700 ounces in silver and from a trace to 6 ounces in gold per ton. The lodes around Breckenridge almost all carry galena, (and its oxidized products,) with traces of copper. The size of the veins is good, and the ore varies in value from 10 to 700 ounces in silver. The erection of smelting furnaces at or near Breckenridge, where water-power could be obtained, would do more for the development of the mineral resources of the Blue River country than anything else that could be devised. The supply of timber for both lumber and fuel, is ample, and good clay for bricks is close at hand. The ores to be treated are of a fair average value, and of a class to furnish a pig-lead of purity, containing from 100 to 500 ounces of silver and considerable gold per ton. The supply of ore would be ample for at least one 10-ton furnace.

In the vicinity of Montezuma much prospecting has been done, and some ore shipped to Georgetown. The mill of the St. Lawrence Company is not yet in order, and work has ceased on the mines for the winter. On Bear Creek the Boston Silver Mining Association is still working on the cross-cut tunnel to strike the Comstock lode at a considerable depth.

At the head of Decatur Gulch, about three miles from Montezuma, several valuable lodes have been opened. The Revenue, Star, and Congress, carry gray-copper and galena ores, and the Treasure Vaults and others yield what is supposed to be a new ore, containing bismuth, sulphur, and silver. The gray-copper lodes have received most attention and development. The Revenue has three shafts 60, 38, and 60 feet in depth. Work will be carried on in this and the Congress lode during the winter. The Revenue shows from 3 to 18 inches of solid ore, which is of good quality, and mills from 100 to 450 ounces per ton, the first-class ore carrying also 10 per cent. of copper, and the second-class ore over 50 per cent. of lead.

Of the bismuth-bearing lodes but little can yet be said. The pure ore assays from 6,000 to 7,000 ounces in silver per ton and contains 40 per cent. of bismuth. The ore, which shows a slight tendency toward crystallization, is intimately mixed with well-defined quartz crystals. Comparatively little work has been done on these lodes. They are situated immediately on top of the range and were discovered late in the summer of 1873. These, as well as the gray-copper veins, are on the main range, at an elevation of fully 12,000 feet above the sea-level, and are partially in Park County, the veins crossing the range diagonally. The district (Geneva) is a new one, and bids fair to be a flourishing mining camp.

With the completion of a railroad into South Park, which would give the Summit County section of the Territory freights at reduced rates, and with the successful working of a smelting-furnace at or near Breckenridge, there can be no doubt that Summit County would rapidly increase in population and wealth. At present, however, with only placer-mines at work, and these only during the summer, the progress of the county is far from satisfactory. The resources of the county in the form of placer and lode mines, coal, agricultural, and grazing land, are ample for the support of a large population, and the amount of land on the streams in the northern and western part of the county, suitable for cultivation, is much larger than is generally supposed.

Some work has been done during the past summer at what are known as the Hanze's Peak gold mines. This placer-camp is situated between Elk and Snake Rivers, and is within ten miles of the Wyoming boundary-line. The area of the ground known to contain gold is about 3,000 acres. The gold is "shot" gold, found on a sandstone bed-rock, and is worth $15 per ounce. About thirty men have found employment there during the summer.

Mention was made in last year's report of the coal-lands of Summit County. They are on the divide between Elk and Bear Rivers. The coal-veins are numerous, and, at the outcropping, from 10 to 15 feet in thickness. They underlie sandstone which is about 150 feet thick. Two qualities of coal have been found. The first and most abundant is a hard lignite. The other is of dull color and brownish streak, and leaves a red ash when burned. This last has been pronounced to be albertite.*

The outlet for this part of Summit County is to some point on the Union Pacific Railroad, and it is probable that permanent settlements will be made during the coming summer in the valleys of the Elk, Bear, and other streams. This once accomplished, the unrivaled grazing facilities of the valleys of the Blue and other streams will result in the speedy settlement of that portion of the county by stock-raisers.

PARK COUNTY.

The bullion product of this county shows an increase over that of last year. This is largely due to the great activity in placer-mining, many hundred acres of new ground having been opened during the year in the South Park and elsewhere, while, at the same time, the older claims have been successfully worked as heretofore. A considerable share in the increase is, however, owing to the erection and successful work of the two smelting-works which have been built in the Park. The one at Dudley, on the Upper Platte, at the foot of Mounts Lincoln and Bross, was erected by Mr. Edward D. Peters, jr., mining engineer, and I am indebted to this gentleman for notes in regard to the works and the operations during the year.

Before the works were built it was the common belief that large amounts of lead-ores could be secured in the vicinity, especially from the Horseshoe mine. As the rich silver-ores from Lincoln and Bross contain a great deal of lime, heavy spar, and also considerable galena, Mr. Peters thought that, taking all the circumstances together, it would be best to erect a blast-furnace, as ores of the above description, together with ores rich in lead, can be most advantageously treated in such works. The furnace erected was a square one, 10 feet 6 inches high, from the tuyeres to the charge-hole, and 36 by 42 inches in section at the tuyeres. Of the latter, three, of 1¾-inch nozzle-diameter, were originally inserted, and a No. 7 Sturtevant blower, giving, at 2,600 revolutions per minute, about ½-inch pressure of mercury, furnished the blast. Subsequently the number of tuyeres was increased to six, and the results were highly beneficial.

These works were finished in November, 1872, and commenced smelting in December of that year. But as no adequate supply of lead-ores could be obtained, it was decided to produce copper matte, and ship it abroad for separation of the metals contained in it. This plan was adopted with much reluctance by Mr. Peters, as the large amount of sulphate of baryta, which the ores at his disposal contained, was certain to prevent the production of a very concentrated matte at the first smelting.

Three distinct varieties of ores were at Mr. Peters's disposal at the time: 1. The largest quantity came from the limestone formation of Lincoln and Bross Mountains, containing the following elements, in about the following proportions: Sulphate of baryta, 55 per cent.; carbonate of lime, 20 per cent.; silica, 20 per cent.; sulphide of lead, 5 per cent., and assaying about 140 ounces per ton in silver. 2. Copper-ores from the porphyritic belt in Mosquito district, containing, approximately, sulphuret of iron, 20 per cent.; copper pyrites, 20 per cent.; zincblende, 25 per cent.; silica, 20 per cent., and sulphate of baryta, 15 per cent., and assaying 30 ounces in silver and 2 ounces in gold per ton. 3. Ores from the quartzite formation underlying the limestone of Buckskin district, containing silica, 70 per cent.; sulphide of lead, 10 per cent.; sulphide of antimony, 10 per cent.; zincblende, 10 per cent., and assaying 18 ounces in silver per ton.

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* Which, judging from its description, it certainly is not. Albertite has a brilliant luster, gives no streak, leaves almost no ash, and does not occur in beds—a tolerably clear case of mistaken identity.—R. W. R.

The only material to flux charges made out of these ores was iron pyrites from the Phillips mine in Buckskin Gulch, containing 75 per cent. of sulphuret of iron and 25 per cent. of gangue, consisting of silica and sulphate of baryta. This ore assayed about $6 per ton in gold, and cost $10 delivered at the furnace. It was roasted in open heaps at an expense of $2 per ton. The only fuel at the disposal of the works was charcoal burnt from spruce, which was delivered at the stock bank for 15 cents per bushel of 2,650 cubic inches. It weighed only 11½ pounds per bushel, and contained 18 per cent. of moisture and 2 per cent. of ashes, while 30 per cent. was lost by screening and handling. It was capable of reducing only 24 parts of lead oxide to lead. It is clear that this coal was, all things considered, about the poorest and most expensive fuel which could be used for such work.

The usual method of preparing and blowing in the furnace was as follows: The hearth and forehearth were packed with a mixture of two parts of ground charcoal and three parts of clay, which was firmly tamped in with tamping-irons. The crucible was cut out so that its deepest point was in front, where the tap-hole was located. This was 18 inches below the level of the tuyeres. From here the bottom of the crucible ascended rapidly toward the back wall to within 8 inches below the tuyères. The crucible was dried thoroughly for several days by means of charcoal brands, and, last of all, an 8-inch breast of common red brick was put in and secured by wedging. After this the furnace was gradually filled to the throat with good charcoal, great care being taken to keep it free from stones and earth. As soon as the flame came through at the throat a very light blast was put on, and six shovels of slag (19 pounds each) were charged, alternating with 18 scoops of charcoal (4½ pounds each.) In about an hour and twenty minutes the slag sank to the tuyeres, and, if it appeared perfectly liquid, the charge was gradually increased, until in about eight hours a burden of sixteen shovels of slag was obtained. If the slag then continued perfectly liquid, running over the lip in a free stream, two shovels of slag were replaced by ore, and this substitution of ore for slag was continued from time to time, until on the second day the furnace reached its regular burden of 250 pounds of ore to 80 pounds of charcoal. But this proportion could never be retained for a long time, the poor quality of the charcoal causing very frequent irregularities. The working of the furnace had, therefore, to be watched very carefully, and required regulation by means of alteration in the quantity and quality of the ore-charges. Usually the charge was of such a composition as to produce a slag of the following composition:

	Per cent.
$Ba\ O$	34
$Ca\ O$	18
$Fe\ O$	15
$Si\ O_3$	25
$Ba\ S$, $Zn\ S$, $Ca\ S$	8
	100

It is seen that in this slag the baryta is the principal base, and that from the nature of its composition it must have a characteristic earthy appearance. On account of the excess of baryta, the slag was extremely liquid, and in spite of its high specific gravity, it permitted a perfect separation of the metal.

The furnace always did its work best under the following conditions: the heat had to be kept low, the blast light, and the ore had to be charged immediately over the four back tuyeres, so as to leave an unburdened column of coal in the center and front of the furnace; the throat had to be kept dark, the "noses" also dark, and about 6 inches in length. Under these conditions the slag was thin and ran freely; the furnace smelted about 9 tons of charge per day, and there was no difficulty found in making blasts of thirty days' duration. The average length of the campaigns for the year was twenty-one and a half days. On the whole, there was no difficulty in using this method of beneficiation as far as the smelting proper is concerned, but a very serious drawback resulted from the presence of the large quantity of heavy spar in the ore. By far the larger part of the sulphuric acid in this mineral was reduced to sulphur, which, combining with the copper, lead, silver, and a large part of the iron, formed a very great proportion of matte, so that on an average it took only 5 tons of ore to make one ton of matte, which of course was not very rich. This matte had to be crushed and calcined in a reverberatory furnace, and then smelted a second time with the addition of 15 per cent. of quartzose ores, yielding finally a regulus assaying 30 per cent. of copper and 900 ounces of silver per ton. This was crushed, sacked, and shipped to Germany for separation. The slag from the concentration smelting was very basic, containing about 60 per cent. of iron. It was very welcome as a valuable flux for the ore-smelting.

In August, 1873, it became certain that no large quantities of lead-ores would ever be available from the vicinity of the works; and as the ores containing so much baryta could not be cheaply roasted before smelting, Mr. Peters decided to erect a reverberatory smelting-furnace to be used instead of the shaft-furnace. This furnace has a hearth 15 feet 6 inches long and 9 feet 6 inches wide, and was completed about September 10. It has been running up to the end of the year without interruption, smelting 8 tons of ore per day, with a consumption of 9 cords of mixed pine and spruce wood, and meeting fully the expectations of the metallurgist. The concentration of the matte in this furnace, where there is not a reducing but an oxidizing atmosphere, is very satisfactory considering the ores to be treated. One ton of matte is now obtained from 10 tons of ore, and the regulus assays from 1,000 to 1,500 ounces of silver per ton. Notwithstanding this high grade, the resulting slag assays only from 4 to 6 ounces of silver per ton.

In another part of this report will be found a very interesting paper by Mr. E. D. Peters, jr., in which his comparison of the shaft-furnace and the reverberatory processes for such ores as he has to treat, shows satisfactorily that the course adopted by him was the right one.

Toward the end of the year the Dudley works ceased shipping their regulus, owing to the high rates of freight and the great discrepancies in assays. From that time on the silver and the greater part of the copper have been separated at the works by a modification of the Patera process. About 93 per cent. of the silver contents of the matte and 80 per cent. of the copper are extracted, and the residue, which contains the gold, is returned to the furnace as a flux. When, in the course of a repetition of this process, the gold has so accumulated in the matte as to reach 200 ounces per ton, it is intended to extract it by means of chlorination.

The production of the smelting-works at Dudley during 1873 was as follows:

	Currency.
Silver	$102,756
Gold	8,549
Copper	2,359
Lead	7,520
	121,184
Estimated coin value, (gold at $1.12½)	$107,719

Professor Hill has put up smelting-works at Alma on the same plan which was followed at his works in Black Hawk, and has been running them successfully during the greater part of the year.

The production of ore in the mining-districts near the two smelting-works mentioned has been, as near as can be ascertained, about 1,800 tons, for which an average of $120 per ton was paid, making a total of $216,000. The Moose mine on Bross Mountain still furnishes the most high-grade ore, and has now considerable reserves in sight, but the Dolly Varden, Hiawatha, and several others have also been very successful. Altogether, Lincoln and Bross Mountains have done far better this year than was expected in the spring. In Buckskin Gulch the production has fallen off somewhat, but from lack of capital rather than of good mines.

Mosquito district promises well for the future, rich discoveries of native silver having been made late in the fall. On the whole, the outlook for the quartz-mining interests of this part of Park County is very encouraging.

In the northern part of Park County much work has been done in Hall Gulch and vicinity. This valley is located on the stage-route from Denver to Fair Play, about sixty miles from the former place. The work here was mostly done by the Hall Valley Silver-Lead Mining and Smelting Company, (limited.) The company has expended a very large amount of money in opening its mines, building an excellent tramway about four miles long, and in the erection of a saw-mill and dressing and smelting works. Most of the company's mines are located high up in the gulch, above the works, and on the south side of the valley. The veins are all parallel, and cross a very high mountain diagonally, so that they can be easily opened by adit-levels. The company has taken advantage of the natural facilities and has opened most of its mines extensively by running many adits at different levels on the veins. The principal mining work has been done on the Leftwick, Whale, and Cold Spring. In the first mentioned the vein was opened, at the end of the year, by six levels and a small discovery-shaft on top of the mountain. Level No. 1, the lowest one, was 200 feet in, and was started a few feet above the level of the creek at that point; level No. 2, 81 feet above No. 1, was 87 feet long; No. 3, 91 feet higher, was 45 feet long; No. 4, 88½ feet above the last, was 32½ feet in; No. 5, 69 feet higher on the mountain, was 42 feet in; No. 6, 73 feet above No. 5, was 40 feet long. All of these levels are driven along the vein and stand in ore. This ore consists principally of copper pyrites, galena being subordinate. Native silver is often visible in the solid ore. The gangue is principally quartz and sulphate of baryta. The ore can be easily sorted by hand into two classes; the first-class ore, being the solid mineral, assays over 350 ounces per ton; the second-class, 120 ounces. These values were obtained by sampling 5 tons of the first and 15 tons of the second class.

The Whale lode is opened by three tunnels run in along the vein, and by a fourth adit, which runs across the country-rock from the foot of the mountain, and will strike the vein at a distance of 800 feet. The latter is intended as the principal working tunnel. It was in, at the end of the year, 123 feet; 255 feet vertically above it is level No. 1, which was 166 feet long; 60 feet higher up is level No. 2, 85 long at the end of the year; and 70 feet still higher is level No. 3, which had reached a length of 122 feet. The faces of all the levels stand in ore. A sample of 20 tons of average ore from this mine assayed 120 ounces of silver per ton. There is a very large amount of fahlore in the ore from this mine; and by far the largest part of the gangue is heavy spar.

The Cold Spring lode, which is the principal mine of the company containing solid galena, lies further down the valley than the two mines described, but it is not so well opened. In fact the principal work on it has been done on top of the bench of the mountain on the discovery and in its vicinity. The vein is a very large one. It is to be regretted that the company has not taken more pains to develop this lode, which is really, together with some others of similar character, to be the basis of the mining and smelting enterprise as it is now planned. I am informed that the manager of the works sees his error now, and is endeavoring to open this and other lead-mines during the winter.

The Hall Valley Silver-Lead Mining and Smelting Company is very fortunate in having on its property, besides a number of valuable silver lodes, a deposit of limonite-iron ore, which may serve as a flux in the smelting process. To judge from the mode of deposition observable in the ore-bank, the limonite is the result of precipitation from waters saturated with sulphate of iron, which, no doubt, comes from some large vein crossing the mountain-spur between the main valley and Handcart Gulch. That such a vein exists is extremely probable, from the fact that iron-deposits of the same kind occur in both gulches, and nearly opposite each other in localities where very small streams of water issue from the mountain side, and cause in the valleys swampy places. An analysis of this iron ore by Mr. H. Stoelting, territorial assayer at Georgetown, gives oxide of iron, 75 per cent.; quartz, 6 per cent.; water, 13 per cent.; and a trace of sulphur.

Charcoal is contracted for in this camp at 13 to 15 cents per bushel, delivered at the smelting-works. Miners receive $4 per day.

The work done in Hall's Gulch by the English company, especially the extensive erection of buildings and the construction of the tramway, has been done at comparatively little expense. This is the case because wood is very abundant, and the immediate commencement of the tramway referred to has rendered transportation of lumber, ore, &c., very cheap. The company intends to be ready for smelting in the summer of 1874.

The total production of Park County during 1873 is given by the Mining Review, of Georgetown, as $459,000.

LAKE COUNTY.

Although but few placer mines have been steadily worked in this county during the year, the yield is somewhat larger than in the previous year.

In the Printer-Boy vein, in California Gulch, several very rich strikes have been made during the year, one of which, in August last, furnished $3,000 of leaf-gold in a small pocket. The mine is opened to a depth of over 300 feet, and even at this depth the ore is still decomposed brown quartz. Horizontally the mine is explored for about 500 feet. At the territorial fair at Denver in the fall of 1873, there was on exhibition from this mine a collection of ore carrying leaf-gold, which, to my knowledge, has never been surpassed in this country, except by the Cederberg mine, in California. The great mass of the ore from this vein, which is about 6 feet wide, carries about $30 in gold per ton, which is easily extracted in the stamp-mill. The mine has produced very regularly about $9,000 per month throughout the year.

The Gray Eagle lode, in the same gulch, is also reported to have been doing well.

The Home Stake, in Tennessee Gulch, is a vein containing ores carrying from 30 to 60 per cent. of lead, and from 200 to 250 ounces of silver. Such ore has been shipped in fair quantity, (considering that the vein is yet in the course of development,) to the smelting-works at Golden.

The mine is opened by a cross-tunnel, 75 feet in length, from which levels have been run along the vein both ways, respectively 200 and 275 feet long. A second cross-tunnel is in the course of construction, 75 feet below the first. This vein is remarkable, because it contains in its ore an arsenical nickel-mineral, which, from the small specimens shown me, I presume to be Gersdorffite ($NiS_2 + NiAs_2$.) This mineral has caused the formation of considerable nickel-speiss at the Golden smelting-works.

In the western portion of Lake County, the country has been much overrun by prospectors during the summer and fall, and at the head-waters of the Arkansas a very large number of lead-veins have been found and located.

According to the Georgetown Mining Review, the total product of Lake County in 1873, in gold and value of ores shipped, was $225,000. To this I add $5,000, the product of some small diggings on Gunnison River, in the northwest part of the county. The same item is to be deducted from the product of Summit County, in which it was included by the Review. Mr. Van Wagenen, the editor, concurs in this correction.

FREMONT COUNTY.

During the past year there has been some excitement in Colorado on account of favorable news received from two districts which have been very little known heretofore. These are the Hardscrabble district, in Fremont County, and the so-called "San Juan Country," a mining region on the Upper Animas River, in Conejos County. The excitement in regard to the latter region bids fair to spread outside of Colorado and the neighboring Territories in the spring.

Hardscrabble district.—In regard to this district I have been favored with an interesting account by Mr. R. Neilson Clark, mining engineer, the superintendent of the Cañon City Coal Mines, which is substantially copied here.

The town of Labran is the shipping-point of the Cañon City coal, and the terminal station of the Arkansas Valley branch of the Denver and Rio Grande Railway.

Eight miles to the southwest lies the Sierra Majado or Wet Mountain. Over the range lies Wet Mountain Valley, one of the garden-spots of Colorado. Beyond it is the Sangre de Christo range, and still farther to the southwest lies San Luis Park, in which are the towns of Del Norte and La Loma, the nearest town to the San Juan mining country.

On the eastern boundary of Wet Mountain Valley, that is, on both slopes of the Sierra Majado, lies the new mining district, the Hardscrable region. It is situated on the waters of Hardscrabble, Oak, and Antelope Creeks, all of which are tributary to the Arkansas River.

Through this region runs a wide belt of trachyte, and in it, running in a northwest and southeast direction, are the mineral lodes.

It has been known for several years that ore existed in this region, but the drift is deep, and the surface-quartz but low in assay, and it was overlooked until some prospectors, killing time until the spring, made up their minds to spend the winter of 1872-'73 in prospecting the heads of the different creeks.

The Senator lode was discovered and opened by them. Its fame and situation (for no mine in Colorado is better situated for ease of access, open winter, pure water, small cost of getting and carrying ores, and proximity of fuel) soon drew around it a large number of prospectors.

Several lodes had been discovered, when in May, 1873, at a miners' meeting called at Brown's Spring (the present site of the town of Rosita,) the Hardscrabble mining district was established and organized. Its boundaries are "all that part of the Wet Mountains included within the boundaries of Fremont County, Colorado, situated between the Arkansas River on the north, the plains on the east, the south line of Fremont County on the south, and Grape Creek on the west." The laws for the government of the district are substantially those of the United States and of Colorado.

Since that date the number of prospectors has increased, and the general result of their efforts is shown by the following list of the mines already located:

Name of mine.	When discovered.	Width of lode.	Width of pay-rock.	Highest assay.	Lowest assay.	Estimated run of pay-rock.	Depth of shaft.
On the waters of Antelope Creek:		*Feet.*	*Inches.*				*Feet.*
Senator	Nov. —, 1872	8	40	$7,635 00	$88 00	$90 00	57
Senator Extension	July —, 1873	4					14
Virginia	Dec. —, 1872	2	10	3,513 00	390 00	300 00	50
West Virginia	— —, 1873	2	8				10
Del Norte	June —, 1873	3	24	212 00	56 00	100 00	40
G. W.	Nov. —, 1872	3	10	267 00	35 00	60 00	110
Tennessee	Dec. —, 1872	6		21 00			41
Gem	Sept. —, 1873	4					40
Kentucky	— —, 1873	4	6				10
Nevada	— —, 1873	4	6	27 00			35
Leviathan	— —, 1873	6	18	251 00	39 00	65 00	82
Stevens	— —, 1873	6		93 00			15
Pioneer	— —, 1873	6	4	80 00			25
M. T.	Apr. —, 1873	3		123 00	23 00	55 00	60
Whistle	— —, 1873	4				85 00	53
Euclid	Aug. —, 1873	2½					16
Rainbow	— —, 1873	4	12				7
and many undeveloped lodes.							
On the waters of Oak Creek:							
Silver Crescent	— —, 1873	6	3				16
Franklin	— —, 1873	10	6	200 00		90 00	70
and several undeveloped lodes.							
On the waters of Hardscrabble Creek:							
Bald Hornet	— —, 1873	4	18	40 00			40
Summit	— —, 1873	6					12
Rattler	— —, 1873	5	20	100 00			26
Yellow Jacket	— —, 1873	5	10	50 00			16
Beaver Ledge	May 23, 1873	8	24	33 00			40
White Horse	July —, 1873	8		21 00			45
Wolvereen	July —, 1873	5	18				10
Lone Star	Aug. —, 1873	2½	8				25
Silver Hill	Aug. —, 1873	4½		23 00	15 00		35
I. X. L.	Aug. —, 1873	4	10	19 00			18
May Flower	— —, 1873			352 00			40
White Cloud	— —, 1873	3	12	33 00			15
and many undeveloped lodes.							

In the column of "Estimated run of pay-rock," the estimates were made by Mr. Clark with all the care possible.

The ores are galena, brittle silver, native silver, black sulphuret of silver, chloride of silver, iron and copper pyrites, blue and green carbonates of copper, and gray copper.

The center of this region is the town of Rosita, situated in the midst of the mines on Hardscrabble Creek, in section 34, township 22, range 71 west.

Its altitude is about 9,000 feet. It is only twenty-eight miles from Labran station, or fifty-eight miles from the town of Pueblo. The thermometer has only been down to zero three times this winter. By the mining-laws of the district any one can secure title to a lot in the town by complying with the following conditions: Thirty days after location $20 must be spent on the lot, and it must be recorded in the clerk's office of Fremont County. In ninety days $50 must be expended in improving it.

It has now a population of two hundred people. Seventy houses have been already erected, including a neat market, two stores, two hotels, one saloon, one livery stable, one blacksmith-shop, one smelting-works, and one public hall, in which a school has been kept, attended by forty scholars. A new saw-mill is running but one and a half miles from town.

The hills and mountains in the neighborhood are covered with a good growth of pine, sufficientfor mine and lumber purposes for many years, if demand is not made upon them for smelting-works.

Mr. Alexander Thornton, a prospector and miner of many years' experience, says in a letter to Mr. Clark, in regard to Hardscrabble district:

> The mines were first discovered in the summer of 1870 by some of the early settlers of Wet Mountain Valley, but they were either ignorant of their true value, or had no time to devote to their development, as little if any work was done at that time to bring the mines into notice. About the middle of November, 1872, a party of miners, returning from a prospecting trip in Western Colorado, happened to pass through the region, and being favorably impressed with the appearance of the rock cropping out from some of the ledges which they examined, sent specimens to the branch mint at Denver for assay, which went near $40 per ton in silver. Satisfied with the result, they at once prepared for working. A cabin was erected, provisions and mining-tools were bought, and shafts were started and prosecuted with vigor on the Senator and Silver Cloud, both of which are large and well-defined veins of 4 and 8 feet in width.
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> * * * * * * *
>
> The great want of this mining-district is some method of working the ores that are accumulating about the different mines. A smelting-works was erected last fall, which was a failure. A small reverberatory furnace was then erected by other parties. This proved a partial success, but, being constructed of almost worthless material, it was used up in a week. Since then ore has been shipped by the car-load from Labran to Denver, but the great expense of transportation proves that only the rich and carefully-selected ores could be thus exported, and leaving, too, a great portion of ore mined as almost waste material. These poorer ores are, of course, much more plentiful than the rich ones, and ought to be made to yield a handsome profit to the miner were suitable works erected in this neighborhood.
>
> There is no section of Colorado which can boast of better natural advantages for working mines or reducing ores than this same region in its close connection to a good coal-field.
>
> It has a climate which is unrivaled in my experience; the winters are mild, with very little snow, so that men can work out of doors and teams haul almost every day during the entire year. There is abundance of timber in the vicinity of the mines. Supplies of all kinds are cheap and abundant. Wet Mountain Valley on one side and the valley of the Arkansas on the other are both great meat, grain, and vegetable producing regions. Rosita is only six miles from the former and thirty miles from the latter, and is accessible any and every day of the year, so that famine and famine prices are something that will never be known in the Hardscrabble district.

Mr. Clark went to the trouble of obtaining measurements of the furnace referred to in the above. It was erected by a Mr. James; his attempt proved futile—perhaps with reason. It was dismantled when Mr. Clark saw it, and, therefore, some of the following figures are only approximate.

The stack was made of strong boiler-plate, being 18 feet high, 5 feet outside diameter, 3 feet inside, lined with fire-brick; it had no bosh.

Air was forced through three circles of tuyeres, seventeen in each circle, giving fifty-one tuyeres in all. The lowest circle was but a little above cinder tap. All the tuyeres played to the center of the furnace, being inclined downward in a common angle. The cinder-tap was about 8 inches higher than the metal-tap. The furnace had falling bottom, like a cupola.

When, then, after kindling a fire and charging with charcoal and some little burden, air was forced through these fifty-one orifices, having together an area of 104 square inches, by means of a large Root's blower worked by a steam-engine, upon charcoal weighing but 12 or 13 pounds to the bushel, it is hardly necessary to state that, except as a pyrotechnical ovation to the goddess of mines and manufactures, but little was accomplished. One thing is certain, if the ore was melted near the mouth, it fell upon this cold draft-air, and soon chilled into a mass as bad for metallurgical purposes as the original ore.

After Mr. James left, a few men collected some scattering fire-brick and built a reverberatory furnace, using the old furnace as a stack. They melted the ore and obtained a matte, which has since been shipped.

From the above it is clear that the location of this district is very advantageous in every respect and especially in regard to coal, that of Cañon City on the one hand and the coking coal of Trinidad on the other. It is the nearest mining-district to the latter now known in Colorado, and will be within eight miles of railroad communication with Trinidad.

The operations of the coal-mines near Cañon City have been nearly trebled in productiveness, as will appear from the following comparative statement. The coal-beds have been described in the report for last year.

Amount of coal mined and shipped by the Coal Creek Colliery, Fremont County, Colorado, in tons of 2,000 pounds.[*]

1872.	Tons.	Distribution in 1872.	Tons.
June	31	Denver and Rio Grande Railway	2,205
July	60	Kansas Pacific Railway	52
August	101	Colorado Central Railroad	72
September	442	Denver Gas Company	16
October	289	Denver market	1,560
November	1,671	Pueblo market	572
December	2,362	Colorado Springs market	348
		Other parties	131
	4,956		4,956

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[*] For these statistics I am indebted to R. Neilson Clark, mining engineer, the superintendent of the above mines.

1873.	Tons.
January	1,260
February	743
March	1,488
April	1,362
May	634
June	407
July	737
August	761
September	1,021
October	1,468
November	1,169
December	1,858
	12,908

Distribution in 1873:	Tons.
Denver and Rio Grande Railway	4,016
Kansas Pacific Railway	252
Colorado Central Railroad	1,555
Denver Gas Company	185
Denver market	3,769
Pueblo market	1,228
Colorado Springs market	1,575
Other parties	328
	12,908

On the Denver and Rio Grande Railway, the engine work was (in January, 1874) 82.59 miles run to every ton of coal used.

The Kansas Pacific Railway, using Fort Scott coal on the eastern and Boulder Valley coal on the western division, ran only 39.87 miles per ton of coal used.

The comparative merits of Cañon City coal and the coal from the localities named, for railroad work, are therefore as 100:48.

CONEJOS COUNTY.

The San Juan country.—Concerning this region a great deal has been said and written in the newspapers of the Territory during 1873.

The mines are located in Baker's Park, on the headwaters of the Las Animas, a tributary of the San Juan River. The country is accessible with some difficulty by way of Pueblo Del Norte and from there up the Rio Grande to the divide, which has to be crossed into Baker's Park. Some of the mines, such as the Little Giant, are spoken of as rich gold-veins, while the great majority are lead-veins, rich in silver. Considerable quantities of the Little Giant ore have been worked in a small and imperfect 5-stamp mill, which is reported to have given a very satisfactory yield.

The coming summer will probably witness great activity in the San Juan country. I have no doubt smelting-works will be erected there; I have knowledge of several parties who intend to put such schemes in operation immediately. The product for 1873 was about $15,000, of which about $12,000 was from the Little Giant, the only developed mine. Probably $2,000 was brought away from the district in specimens. The Annie, a small mine in Summit district, west of Baker's Park, has become famous for rich specimens. During the summer there was a report of its sale at a high price, on the strength of such indications of value.

CHAPTER VII.

NEW MEXICO.

The progress made during the year in the mining industries of this Territory is not so great as was anticipated. The check given to the business of railway construction in the United States affects most unfavorably a region which must look to improved communication for the reduction of freights and other expenses, and also for a much needed infusion of Anglo-Saxon energy. The Indian and Mexican populations of New Mexico, whatever may be their virtues, do not abound in enterprise and public spirit. Moreover, a large part of the best mineral land in the Territory is held under old Spanish grants, and cannot be so freely explored as it would be if individual prospectors were here encouraged, as they are elsewhere, by the general mining law, to discover and develop new deposits. I estimate the total yield of the Territory for 1873, in gold and silver, at $500,000.

The Maxwell grant, in the northern part of the Territory, is owned by the Maxwell Land Grant and Railway Company, an English corporation, which has for the present suspended active operations. The descriptions given in former reports of this property and its condition are still applicable. In June, 1873, I passed twice through Cimarron, the pleasant village built by the company. Nothing was going on there, and it was not known by the officials when active operations would be resumed. There seemed to be some expectations that the company would take measures to utilize its railway franchise, before expending more money on its quartz or placer mines. A few miners were washing gold on private account in the ravines. Judging from the notices published by Mr. Morley, the vice-president, in New Mexican papers, I infer that some difficulty is apprehended in the maintenance of the title to a part, at least, of the large grant claimed by the company, on which numerous ranch-men and stock-raisers are said to have settled.

THE ORTIZ MINE GRANT.

By an arrangement with the New Mexico Mining Company, I was enabled to make without expense to the Government a careful examination of the Ortiz mine grant, alluded to in former reports. The owners of the property received the benefit of my field-notes and opinions, and consented that the material obtained should be freely used in my next annual report. Accordingly, I incorporate here the essential portions of the description furnished to them. It was their intention to sell the property to a company organized in London for the purpose of carrying out the plan of hydraulic working, mentioned below. I am unable to say whether this plan has succeeded.

The Ortiz mine grant, situated about twenty-five miles southwesterly from Santa Fé, comprises about 69,000 acres, or one hundred and eight square miles, in the form of a square, having ten miles and a little over sixteen chains on each side. The central part of this square is occupied, to the extent of about 25,000 acres, by the old Placer or San Lazaro Mountains, an isolated range, belonging to the easternmost of the two systems into which the Rocky Mountains are here divided. The remaining 44,000 acres are mainly *mesas*, or inclined table-lands, sloping down from the mountains on every side toward the valleys of neighboring rivers, and composed of *débris* from the central range. These mesas are deeply intersected by ravines or arroyos, revealing in many places places the underlying rock.

Aside from small areas capable of cultivation, and a considerable extent of surface suitable for grazing, the value of this grant lies in its mineral wealth. This is now known to include—

1. Gold, in numerous quartz veins in the mountains, and distributed in the arroyos and mesas;
2. Coal, in the sandstones underlying the mesas;
3. Iron ore, in veins, and widely scattered in bowlders;
4. Fire-clay and building-stone.

Copper ore has been found, but not extensively exploited, and silver-ore occurs in specimens (argentiferous galena) which have not been traced to their original localities.

The great extent of the tract to be examined made it necessary, if the examination was to be at all satisfactory, to confine it to those points which were deemed most important at the present time. I accordingly gave my attention chiefly to the subjects of the gold and the coal, making incidental observations only upon other matters.

In investigating the various gold-deposits, I visited the principal quartz mines, and examined their underground workings; but, having soon arrived at the conclusion that the placers constitute the most largely and immediately remunerative resources of the property, I subjected these to more extended study. There being no time for sinking new shafts through the gravel of the mesas, for testing the value of the ground, I had recourse to the natural exposures in the side of the arroyos, to tests taken from the surface, and to the workings of the Mexicans, who have for nearly forty years, sometimes in large numbers, worked these placers in a rude and limited way. Their peculiar method makes it easy to determine the average quality of the ground in which they work. The arroyos being dry during the greater part of the year, the miners are accustomed to haul water to the place of working in casks, mounted on wheels and drawn by donkeys, and to pour it into shallow tanks dug in the earth, called *estancas*. In these they wash the gravel and earth, by means of wooden bowls or *bateas*, continuing the operation until the water is so thick with mud as to be no longer serviceable. Working very slowly and under great disadvantage, losing the fine gold, and working by no means all day long or every day in the week, they naturally wash the richest material only, and this they seek by means of rude shafts dug in the gravel, without timbering, from the bottoms of which they burrow as far as safety or convenience will permit, along the richest layers. The gravel thus obtained is hoisted to the surface in rawhide buckets, by means of windlasses—a modern improvement on the earlier method followed in these placers, when the miners climbed out upon notched sticks, bearing their burdens on their backs or heads. The layers of gravel passed through by the shafts in reaching the *mantas* or rich streaks are cast aside as of no value, and the surface of a Mexican placer is covered with heaps of these "strippings," lying by the mouths of the shafts. By the *estancas* are other heaps, consisting of the tailings from the *bateas*. The richness of these proves nothing, of course, except the amount of gold lost by the Mexicans in their rapid operations with muddy water. But the strippings are really samples of the ground, minus the richest layers, from the top to the bottom of the shafts. I have, therefore, great confidence in the estimates based upon the tests of Mexican strippings. Unfortunately these miners, keeping as near as possible to the springs whence they obtain their water, have worked but a limited area in comparison with the vast extent of the auriferous gravel on the grant, and this will explain why my own estimates, for the yield of actual operations on a large scale, with the aid of water, are confined to a tract which, although it will sustain such operations for many years, is yet insignificant in comparison with the whole.

The nature of the examination made with regard to coal and iron will sufficiently appear in the sequel. The other point of importance was the question of water supply, without which it will be impossible to develop the placers. As a preliminary survey had already been made by Captain Davis, whom I regard as fully competent, from much experience in similar undertakings, to determine such a question, and as I had no time to spare from the placers themselves for repeating that survey, I made merely a wide reconnaissance of the general course proposed, noting whatever appeared likely to prove costly or troublesome in the work, and also riding to the point on the Pecos where the water was to be taken, determining the approximate relative altitudes by means of the barometer, and measuring the amount of water in the stream.

The geological features of the grant were studied so far as they promised to throw light upon the various mineral deposits. It is sufficient here to say that the mountains consist principally of hard, bluish syenite; that the rock under the mesas is principally sandstone and conglomerate of recent (probably Cretaceous) age, and that the whole grant appears to be traversed by a considerable number of dikes of porphyry.

Gold in quartz.—The number and extent of auriferous quartz veins in the mountains of this grant is extraordinary. Not only the Cunningham, Ortiz, Brehm, Candelaria, and other mines which have been long known and worked, but scores of promising outcrops which still await development, render this isolated range remarkable. They are characterized, either, like the Cunningham, by enormous width, or, like the Ortiz and Candelaria, (which may be distant parts of one vein,) by the occurrence of rich *bonanzas* or "chimneys" of rich ore. A large chimney has been extracted from the Candelaria with great profit, and three extensive *bonanzas* have been exploited in the Ortiz. At the present moment, however, both these mines appear to lack reserves of pay-ore. The Ortiz, which I examined with care, is a very well-defined vein, the upper parts of which were found to contain oxidized and decomposed ore. At 180 feet from the surface, the deepest point of the present shaft, massive pyrite ores are making their appearance. (I make my remarks brief on these quartz mines, referring to the accounts of them contained in my report on mines and mining in the States and Territories west of the Rocky Mountains, March, 1870, page 404 and following pages, containing descriptions of them and a profile of the Ortiz in particular—all of which I have now verified by personal inspection.)

The difficulty in working the Cunningham as a quartz-mine arises from its great size, and the manner in which the rich rock is scattered through it, in bunches and seams which it requires the eye of a Mexican to detect, and which cannot be extracted on a large scale by a regular system. The huge, irregular excavation or quarry, known as the Cunningham mine, has resulted from the "coyoting" of the Mexicans to find and follow the rich rock. The width of the Cunningham outcrop is 600 feet; and its course can be traced for several miles. That it is a true fissure, one can scarcely doubt after examining the nature of the vein-matter, which is in many places, at the outcrop, a breccia of fragments of the various rocks of the "country," inclosed in a matrix of quartz. But the great dimensions of the fissure have prevented the formation, near the surface, of a defined "pay-streak" of rich rock By sinking along the foot-wall of the vein (which is a porphyry dike, while the hanging-wall is syenite) a narrower, more concentrated, and more regular vein-formation will doubtless be reached in depth. This is, at least, in accordance with experience acquired in similar instances, in West-American practice.

The Brehm, Berardo, and a number of other veins of quartz on the property, promise to be exceedingly valuable and productive, but are not now in condition to furnish a trustworthy basis for estimates. The circumstance observed by me, that on some parts of the grant the Mexicans are running arrastras, is indication that they are able to obtain from these veins rock yielding at least $30 per ton. This they doubtless select by hand—a system which could probably be adopted in regular working of the mines, only it must be borne in mind that special and local experience is required to recognize the rich portions of the decomposed vein-matter. To test this point, I selected from the three leading mines specimens which I supposed to be rich, from their general appearance, though they did not present visible free gold. In all these mines, I had already obtained, by the aid of more experienced eyes, samples that carried a great deal of gold; I had also got large returns by crushing the quartz and washing it in a pan—taking my samples from the refuse dumps of *bonanza* workings. I was therefore surprised and mortified to find that the specimens I had selected proved upon assay to be practically barren. The circumstance has no practical bearing, except to show the difficulty of sorting the rock, and incidentally to explain why, in spite of that difficulty, such a sorting is indispensable so long as large and well-defined chimneys are not open for exploitation.

The company owns a 40-stamp mill, (20 stamps now in running order, with 20 more available after a fortnight's fitting up,) with a fine 60-horse-power engine and boilers, and several arrastras. There is also a railroad to the Ortiz mine, one and one-third miles long, (somewhat out of repair,) which passes close by the Cunningham mine, lying, in fact, for a considerable distance, obliquely across the outcrop of the Cunningham vein. The mill, offices, dwellings, railroad, pumps, and water-tanks, and other improvements necessary for mining, are fairly worth as they stand, about $125,000—that is, they could not be replaced for less than that sum. In view of this fact the policy to be adopted with regard to the quartz-mines of the property appears to me very simple. It is, to continue operations in depth upon the Ortiz mine, underrunning the old chimneys and penetrating the zone of sulphurets; to follow a system of leisurely prospecting upon the innumerable promising outcrops of the quartz-veins on the grant, including a continuance of operations on the Brehm, Cunningham, and Candelaria; and to use the mill in testing the ores from these mines. The discovery of a single *bonanza* like the five or six already exploited would very handsomely reward these explorations, which, with the facilities at hand, need not be expensive. I must add that, in my opinion, the Ortiz mine, which is far more extensively developed than the others, will be again productive of rich rock in depth; and the barren, or "cap rock," now met with at the water-line in that mine, is no argument against this opinion, when the well-defined nature of the lode, and the distribution of *bonanzas* in its upper portions are fairly considered.

Gold in placers.—The operations in quartz-mining should be, however, for some years at least, subordinate to the active development of the gravel-placers, which promise at present an immediate, large, and certain profit. It is, indeed, chiefly in their bearing upon the value of the placers that I call attention to the extraordinary number and size of the gold-bearing quartz-veins, of which I shall speak again.

The gravel covering the mesas is chiefly syenite, porphyry, and quartzite, showing by its lithological character, as well as by the sharply-angular character of its fragments, that it is derived from the mountains which it surrounds, and has not been washed thither from a distance. The character of the gold found in it is another proof of this fact. It is largely "quartz gold," that is, not rounded and water-worn, but irregular and frequently twisted in form, usually very bright, and always of fine quality, as is the gold of the quartz-veins (over eight hundred thousandths, and often over nine hundred thousandths fine.) Moreover, an examination of the different mesas shows that those areas which have received the surface *débris* from the most numerous and the largest quartz-veins are precisely those which are found most richly impregnated with gold. There can be, therefore, no doubt that the San Lazaro Mountains, in the center of the grant, are the source of the gold in the placers. Finally, the vast area of these gravel mesas indicates an enormous denudation, amounting to many hundreds of feet of vertical height, of the mountains themselves, thus giving ample cause for the accumulation of great quantities of gold in the *débris*.

The main ridge or backbone of the mountains occupies roughly a line like the curve of a horseshoe, open toward the northeast. The Cunningham arroyo rises in the very heart of the range, and receives nearly all the interior wash, including that of the largest quartz-veins. The remainder of this wash passes out through the Las Norias Arroyo. The Arroyo Viejo, separated from the Las Norias by a line of low hills, is merely a gulch in the mesa, and has never been a channel for the *débris* of denudation. The mesa from the Cunningham Arroyo to the Arroyo Viejo is the product of the wash through the upper ravine of the former, spreading out fan-like as it approaches the valley.

On the western side of the grant, the large cañon and mesa of the Uña de Gato (or Cat's-paw, named from a species of flowering locust-tree) constitutes another important line of drainage from the mountains, intersecting numerous quartz-veins. There is also a large cañon on the north, just east of the new coal-mine, which carries a good deal of quartz gravel, and finally, the wide mesa on the southwest, between the mountains and the village Real de San Francisco, receives the wash of a considerable number of gold-bearing veins, including the Candelaria.

On the other hand, a study of the water-courses shows that the divide between the Galisteo and the Tuerto runs obliquely through the property, from northwest to southeast. Along this line there is naturally no depth of gravel and no placer-ground of importance. The southern part of this divide is, however, more valuable to the grant than if it were gravel mesa as rich as the Cunningham, since it is along this ridge that the only practicable line of water-channel must pass, to reach and command the heads of the mesas.

I divide the mesas of this grant, according to their apparent relative value and the degree of certainty with which I am able to pronounce upon them from my examination, into twelve sections, as follows:

1. The Cunningham Arroyo and the Arroyo Viejo, with the mesa between, from the head near the Real de Dolores for about a mile and a half, measured down the Galisteo road; area, about 600 acres. This is the ground most thoroughly explored by me, and now worked by the Mexicans of the neighboring village. The deepest shafts in the gravel of which I have positive knowledge are 80 feet deep. They are in the ground towards the Arroyo Viejo, near the Cunningham Arroyo. The shafts are sunk to 35 feet, but do not reach the real bed-rock. They pass through three rich streaks or *mantas*, the aggregate thickness of which is more than one-eighth of the depth of the shafts. Toward the Arroyo Viejo these streaks lie depeer, and have consequently been less worked. Possibly on that side they are not so well defined, but the general average of the gravel is fully as high. The Arroyo Viejo itself, which is merely a gulch in the gravel, is notorious for its richness, and is worked over and over by the Mexicans after every rainy season.

It is safe to estimate the average depth of gravel in the 600 acres referred to at 13 yards, after deducting all the spaces excavated by the arroyos or Mexican shafts and drifts. The average quality of ground was determined as follows: thirty-four tests of the strippings rejected by the Mexicans from different shafts gave an average of

48.4 cents per cubic yard. A large number of Mexican washings observed and recorded on the spot showed that the *mantas* yield from 10 cents to 50 cents the *batea*, or $9 to $45 the cubic yard; but these figures being too high for average estimates, (since the Mexicans select the richest spots,) I preferred to calculate upon the result of 40 panfuls worked by rocker, and consisting of selected strippings, that is to say, of material rejected by the Mexicans, but better than the average of their rejected material, and worked by some American adventurers, who obtained it for the labor of hoisting it out of the shafts and saving the Mexican miners a certain amount of trouble. These strippings yielded over $3 in all, or at the rate of 8 cents to the pan, or more than $8 per cubic yard. By accurate measurement, 135 pans like the one I employed are contained in a cubic yard, but in this instance the gravel was not accurately measured, being only counted by the bucketful. Hence I assume for safety the lowest reasonable figures. The average of the *mantas* is certainly much higher than this.

It remains to decide how much of the richer material remains in the ground. Assuming that the *mantas* occur on the half of the area under consideration toward the Cunningham Arroyo, and that they are not so distinctly defined toward the Arroyo Viejo, (an asumption which is made only because I could not so thoroughly explore the ground in depth on that side;) assuming, moreover, that the Mexicans have extracted all that can be taken out without danger by their rude method of drifting, (which is certainly far from being the case, since they are still actively working, with abundance of new ground before them, and habitually leaving at least half the *mantas* standing as safety-pillars;) assuming finally, that the value of the *mantas* is $8 per cubic yard, though this is really the value of a class of gravel not regarded as rich by the Mexicans—we have, as the quantity of rich ground in this area, one-half the area covered by one-eighth the average depth of gravel, less two-thirds of this quantity, assumed to have been extracted, or one forty-eighth of the whole amount of gravel, worth $8 per cubic yard, while the remainder is worth 48.4 cents per cubic yard. Hence the average value is 64 cents. Making a further deduction of 22 per cent. for bowlders, we have 50 cents per cubic yard as a safe estimate for the whole of the gravel on this area. No account is here taken of the gold on the deep bed-rock, which is undoubtedly a richer zone than any above. It may be mentioned that a series of 180 tests made by Captain Davis on this mesa from strippings alone gave 61½ cents per cubic yard as the average value, and it is my judgment that those results, obtained by an examination more prolonged on this one spot than my own, are worthy of confidence. In the following estimates I adhere to the basis furnished by my own tests, thus giving an increased margin of safety.

On the supposition that a continuous stream of 1,000 miners' inches (2,333 cubic feet per minute) of water were delivered at the head of this mesa, and that the night-water was saved, so that for ten hours daily (allowance of 400 inches waste being made) 2,000 inches could be made effective, I estimate that the area of 600 acres here referred to would give full employment for this water by the hydraulic method for twenty-three years, as follows: Average amount of gravel per acre, 62,660 cubic yards; amount moved daily by 2,000 inches water, 6,000 cubic yards; one acre is therefore removed in 10.44 days. Six hundred acres would last 6,266 days, or 23.2 years, at 270 working-days in each year.

The amount of gravel here estimated as moved daily by 2,000 inches of water is about one-tenth the weight of the water. At Dutch Flat and Gold Run, in California, one-fifth is the proportion; but the gravel at those points is chiefly earth and very easily moved. In the Blue gravel claims, on the other hand, the quantity of water used is enormous; but there the gravel is very heavy, and firmly cemented together. On this grant the gravel is heavy but perfectly loose and easy to pipe down. If a larger proportion of it than one-tenth the weight of water used can be moved, then the 600 acres here referred to will not last so long as I have estimated, but the cost of working will be less, and not only the daily profit but the profit per cubic yard will be greater than my estimates.

The mesa descends toward the valley with a grade of about 100 feet to the mile, not counting the final break-down of some 250 feet, six miles from the head of the mesa, where it terminates in bluffs of uplifted sandstone, which hold it like a rim. There is, therefore, a fine natural outlet for tailings, while, by taking advantage of the slope of thesandstone bed-rock in the upper area under discussion, and of the facilities of access afforded by the arroyos, expensive dead-work may be avoided. I believe, therefore, that 8 cents per cubic yard of gravel (aside from the interest on the cost of bringing water) would amply cover the expenses of working, including all administration upon the property and including, also, the watching and repairing of ditch, flumes, pipes, &c.

2. The remainder of the same arroyos and mesa, comprising an area of about 4,500 acres, was prospected on the surface in the arroyos and along the edges of the mesa. Every test showed some particles of gold, and over a large part of the mesa the gravel appears to be as deep as on the area first described. Far down toward the Galisteo the bed-rock comes nearer to the surface, giving an excellent opportunity for profitable second use of the water after it has been employed above in the hydraulic working. It is not necessary to enter into detailed estimates of the ground under this head. There is an endless amount of it in this and other mesas, where sluicing the bed-rock would yield a profit as great in proportion to the effective amount of water as the removal of the deep gravel above.

Indeed, the plan proposed by Captain Davis, seven years ago, for bringing water to this grant was based (in the absence of the necessary capital for a large ditch to the upper grounds) upon the idea of working the lower parts of the mesas only and with a smaller amount of water. It must be added that it is not safe to calculate upon the effective use as "second water" of more than one-half the original delivery of "first water."

It is upon the upper and lower Cunningham mesa that operations should be commenced, and the reasonable estimate of profit from working with a ditch delivering 1,000 inches through the twenty-four hours, with the use of night-water and second water, as above explained, would be as follows:

Daily yield from 6,000 cubic yards of gravel on area No. 1, at 50 cents		$3,000
One-half from use of second water in selected ground		1,500
Total gross daily yield		4,500
Expense, except interest on the cost of the ditch:		
On 6,000 cubic yards of gravel	$480	
One-half for second water	240	
Total daily expense		720
Daily profit		3,780

The conditions of the water-supply and the ordinary necessities of the hydraulic process (cleaning bed-rock sluices, arranging slopes, &c.,) make it prudent to estimate for not more than nine months of full working per annum. Companies having continuous water in California usually lose in these operations a couple of months every year. At two hundred and seventy days per annum, the above daily profit would amount to $1,020,600. These estimates are in coin-value.

It was not necessary to go farther than the Cunningham mesa to find ample basis for very large returns for more than fifty years—the first score of years being capable of demonstration upon thorough tests; but the reserves of promising placer-ground outside of this are immense. I continue my description of the different areas, forbearing to make estimates of value or profit, partly for want of thorough prospecting of the ground, partly because there is little chance of developing it for many years to come, unless, indeed, the project of a very large ditch from the Rio Grande should some day be executed. This would doubtless be an enormously expensive work, as the river would have to be tapped above the Taos Cañon, and a line followed more than one hundred and fifty miles long. Having made no reconnaissance of the ground, I am not prepared to say whether the plan is feasible, but I incline to think it merely a question of time and money. It may be unhesitatingly declared that 10,000 inches of water could be employed with great profit for many years upon the mesas of the Ortiz Mine Grant, as the following list, in continuation of that already given, will indicate:

3. The Las Norias Arroyo, with a small amount of rich gravel on the east and a long narrow mesa on the west, over which passes the Santa Fé road. The side of this mesa toward the Las Norias Arroyo shows deep gravel as rich as that on the Cunningham mesa. Beyond the road, the wash belongs largely to another cañon, which carries less quartz and probably less gold. Estimating the rich ground to extend to the line of the road only, we have an area of about 800 acres.

4. The famous West Bonanza in the wide Uña de Gato Cañon, comprising about 2,600 acres. This I was not able to examine at all, and know concerning it only that it has been extensively worked by the Mexicans of the Real de San Francisco, and is commonly reported to have been the most productive of the old placers.

5. The workings on the Tuerto slope, below the Candelaria and other quartz mines. I obtained here good prospects with the pan, and observed traces of Mexican workings. But the gravel does not appear to be deep, perhaps not more than 15 feet on the average. The area referred to comprises about 4,400 acres.

6. A portion of the northwestern slope of the Tuerto Mountains, included within this grant in sections 95, 96, 97, 98, and 99, and comprising about 2,000 acres. This I did not examine except by riding over a part of it. It has been famous for rich diggings, and is full of old Mexican shafts.

7. Cañimo Valley, north of Cañimo Peak, comprising about 1,800 acres. This area has been worked some by Mexicans, who appear to consider it not so good as the Cunningham, Tuerto, or West Bonanza. I did not examine it except at the head of the gulch, where I obtained fair prospects by panning.

8. Large mesas in the northwest corner of the grant, comprising about 6,400 acres. There are said to be old Mexican workings here, but the only visits I made to any part of this area were wholly occupied with the examination of the coal-beds.

9. Large arroyo and mesa east of the new coal mine in sections 6, 7,

14, 15, 26, and 27, comprising about 2,000 acres. The character of the gravel (abounding in quartzite and *tepustete* or ironstone pebbles) led me to expect good ground here, and some slight prospecting gave encouraging results; but on subsequently examining the bluff of the mesa toward the Galisteo, I found that the bulk of what seemed a very deep deposit was formed by an enormous development of the uplifted sandstones. It is still my impression, however, that profitable hydraulic working could be carried on for some years on the upper part of this mesa, the lower portion where the gravel is thin being sluiced with the waste-water.

10. The mesas extending from this arroyo to the Santa Fé road, comprising about 3,200 acres. I here found coarse gold in the arroyos and scanty fine colors in every panful taken from the surface. But the gravel is irregular and mostly very thin, over bed-rock of sandstone and in many places porphyry dikes.

11. A portion of the southeast corner of the grant in sections 86 to 95, inclusive, comprising about 5,700 acres, of which I know nothing positively, but believe, from its position with reference to the mountains and from the absence of Mexican workings, that it is poor in gold.

12. The high ground of the divide between the Tuerto and the Galisteo, northwest and southeast of the mountains, in sections 71, 72, 68, 20, 21, and 22, comprising about 4,500 acres with little gravel. Even if this ground were rich, it is not conveniently located for working from the proposed ditch. In addition to this there are about 5,500 acres of fragments otherwise unaccounted for, making up the aggregate of 44,000 acres of table-land. The remaining 25,000 acres of the grant belong to the mountains proper.

Coal.—The sandstones surrounding and abutting upon the syenitic range of San Lazaro, and containing the coal-beds, are probably of Cretaceous* age, like those of Trinidad and Cañon City in southern Colorado. They belong, therefore, to the great lignite formation extending along the eastern flank of the Rocky Mountains. But the coal found upon this grant is, so far as discoveries have hitherto gone, unique. The presence of dikes of porphyry intersecting the sandstones, and sometimes overlapped or intercalated in them, has altered the lignite to a true anthracite, as is shown by its appearance and behavior, and has been repeatedly proved by chemical analysis. It burns without smoke and leaves only 2 or 3 per cent. of light ash. The grate-bars under the boiler at the Ortiz Mill, after three months' firing with this coal, show no trace of injury, a clear proof of its purity. Many eminent geologists have visited the grant for the purpose of examining this singular occurrence, and it has been described by Cox, Owen, Hayden, and Lesquereux. A good practical description of the two main openings, called the old and new mines, will be found in my report published in 1870. It was prepared by my assistant, Mr. Brückner.

So far as I know, the geologists who have visited this locality have not discovered or not recognized more than two different coal-beds. The sections exposed at the old and new mines differ enough to lead to the belief that the two beds are not identical, but no published account has mentioned an actual exposure of several beds over one another in place. During my visit Colonel Anderson accidentally discovered such an exposure in the side of the cañon a few hundred feet only below the old mine in a shallow gully, probably the result of the last rainy season. The section here exposed is as follows, measured from the bottom of the bluff to the top of the mesa:

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* On the authority of Hayden and Lesquereux, I have called these rocks Tertiary in my report to the owners of this property, and in other writings; but I now prefer to follow Leconte, Newberry, and others, in classing the "Galisteo group" as Cretaceous. Probably all the lignites of the Rocky Mountains, south of the Union Pacific Railroad, are Cretaceous. The Cañon City beds may form an exception, but this I doubt.—R. W. R.

		Feet.	Inches.
	Debris of bluff	30	
No. 1.	Excellent coal	4	6
	Sandstone and shale	12	
No. 2.	Coal apparently good	6	
	Sandstone and shale	14	
No. 3.	Lower coal, 10 inches Slate, 8 inches Upper coal, 26 inches	3	8
	Sandstone and shale	6	
No. 4.	Coal, 14 inches Sandstone and slate, 3 feet Coal, 3 feet	7	2
	Slate	1	
	Ferruginous sandstone	1	
	Shale	2	
	Sandstone	1	
	Shaly coal		8
	Shale	3	
	Sandstone	2	
	Carbonaceous shale	3	7
	Coal		5
	Shale and sandstone	10	
	Gravel on mesa	10	
	Total height	118	

This proves the existence of at least four beds of coal, all of which may be worked. The locations where coal outcrops have been discovered on the grant, and on the neighboring mesas northeast and west of the grant, together with the general extension and position of the sandstones, indicate that the latter underlie at least 30,000 acres of the grant, and that throughout that area the existence of one or other of these workable coal-beds may be reasonably inferred; while the wide distribution of porphyry indicates that a vast amount of the coal may be expected to be anthracite. This fuel will command the market for railroad and metallurgical purposes whenever such a demand shall arise. It is cheaper than wood (though the resinous piñon is abundant) for use on the grant itself, and in conjunction with the excellent fire-clay occurring near by in large deposits, it might be profitably utilized in the manufacture of iron.

Iron-ores.—These occur abundantly on the grant in scattered bowlders and large outcrops of magnetic iron, and as siderite and limonite associated with the coal-beds. The latter deposits are, I fear, thin and irregular, and not likely to be worked with profit except where they can be extracted simultaneously with the coal. The outcrops of magnetic iron, on the other hand, though often large and well-defined, (20 feet wide in one case,) are auriferous, and moreover usually carry quartz, with gold on one or both sides. I hold them, therefore, to be outcrops of auriferous veins; and, if this opinion is correct, they will turn to pyrites in depth. Hence I do not see a basis for permanent deep iron mines on the grant, though such veins may occur in the syenite. But there is certainly enough very pure iron-ore available at and near the surface to maintain a profitable manufacture for a long time. Moreover, New Mexico abounds in iron-ore, and if this property contains, as now appears to be the case, the only suitable fuel, there will be no difficulty in commanding the raw material and in monopolizing the market. The approach of two railways, one or both of which will necessarily follow the Galisteo as the best pass in this region, brings the day near when this coal must become a source of profit.

The Ditch.—The immediate future of this property depends chiefly upon the working of its placers, and this depends entirely upon the introduction of water. I have examined the field-notes of the preliminary survey of Captain Davis, made in 1866 or 1867, discussed with him at length the points involved, and reconnoitered the ground hastily, besides riding to the Upper Pecos and measuring the amount of water in that stream. The river was lower than it had been at the same season in any previous year for a generation, by reason of the lack of snow last winter in the mountains and the absence of rain for nine months—an unprecedented drought. Nevertheless, I found 3,600 miner's inches running in it, and from numerous inquiries of residents in the neighborhood I am satisfied that the driest season (September and October) of ordinary years does not reduce the volume of the stream materially below this amount. A small quantity is used by the Mexican ranches for irrigation in the season of the year when water is abundant in the river. In part of December, January and February, the water at the head of the ditch in this locality will be liable to freeze, and interrupt operations. This period should, therefore, be taken for cleaning up, laying out grounds, &c., leaving nine months or more for active operations.

The estimates for hydraulic operations above given are based on a delivery of one thousand inches continuously, which will require (to allow for evaporation and seepage) 1,400 inches to be taken from the Pecos, a quantity far within the reasonable estimate of the capacity of that stream.

The line of the ditch after emerging from the mountains will follow the divides between the Pecos, Cañon Blanco, Tejeres, and Tuerto on one side, and the Galisteo on the other. In other words, it must go around the head of the Galisteo River. To bring the water to the head of the Cunningham mesa, however, it will be necessary to cross, with pipes a "sag" in the divide 280 feet deep and (according to Captain Davis) eight miles wide from one crest to the other. (I think this distance, which he gave me from memory, may be overestimated. This part of the line is not included in his field-notes, since, on arriving at this sag, he was obliged to give up the idea of crossing it, and to lay his line in such a way as to enter the placers far down on the Cunningham mesa, sacrificing 280 feet of "head.")

The only other expensive part of the ditch would be the rocky cañons and divides between the Pecos and the high mesa. The middle and largest portion of the ditch can be excavated in the adobe soil of the mesa (which holds water admirably) at about $750 per mile. After making all reasonable allowances, I am of opinion that the whole ditch, including the pipe, can be finished, and the water introduced at the head of the Cunningham mesa, (whence it could be carried without difficulty to any gravel that I know of on the grant,) for a sum not exceeding $500,000 in currency. It is evident that only a large expenditure of capital can ever utilize the resources of this property, and, so far as my experience goes, the public sentiment of the Territory is decidedly that of cordial good-will toward the enterprise.

The New Placer-mines.—I am indebted to Mr. A. Z. Huggins, of Santa Fé, for notes on this property, a part of which I also examined personally. It is known as the San Pedro and Cañon del Agua grants, and is situated in Bernalillo and Santa Fé Counties, about forty miles south-southwest from the city of Santa Fé. It contains in all about 40,000 acres, embracing gold, silver, and copper mines, granite and marble deposits, and extensive agricultural, grazing, and timber lands.

The Cañon del Agua grant.—This grant covers the northeasterly portion of the property, and contains 3,501$\frac{31}{100}$ acres. This is known as the "mineral grant," as it embraces a number of noted mines, and is of comparatively little importance, except for mining purposes. The Tuerto Mountains, which are some three miles in length, extend over the larger part of the tract, and in and around it are the mines referred to.

The discovery of gold in the washes of the Tuerto was made (as I am informed by Señor Francisco Aranda, one of the discoverers and a long-time resident of Real del San Francisco) in the year 1842. The first gold discovered was in the Cañon Bonanza Viejo, from whence in the years following very large amounts are reported to have been taken. After this discovery prospecting was prosecuted in all the cañons around the mountain, when every cañon that showed a deposit of earth was found to be rich in gold. The most important of these were named respectively Bonanza Viejo, Bonanzita de las Granos, Bonanza del Cañon, Bonanzita de Valentine Vasquez, Bonanza del Mater Hoso, and Bonanzita del Cabo del Mano.

From the date of the discovery of the placers, the immigration was so rapid that is said that in 1847 the population of Real del San Francisco reached nearly 4,000 souls, and was larger than that of any other town in the Territory. In that year the town and vicinity contained no less than twenty large stores and thirty shops or small stores, all of which did a thriving business in the exchange of gold. The number of miners at that time is estimated at from eight hundred to a thousand, all of whom, although their mode of working was of the most primitive kind, were abundantly successful in obtaining gold.

It is impossible even to approximate to the amounts taken out, as the miners, owing to the lawless character of a portion of the population, kept their operations as much to themselves as possible. But it is stated on undoubted authority that the principal stores often averaged as high as $1,600 each as their weekly exchanges with the miners.

Notwithstanding this, it will be seen that all the work done was in effect little more than merely the prospecting of the placers. The miners only sought for the coarse gold, as indeed, by the crude means used, they could hope to save no other; and in all their washing, it is universally agreed that they did not obtain one-half of the gold washed.

As a fair index of the aggregate amount of earth worked in these placers, I will instance the Bonanzita de los Granos, which is a large placer, and has probably been worked more in proportion to its extent than any other. This placer covers an area of perhaps two hundred acres, with probably an average depth of 25 feet of gold-bearing earth. Less than one-third of the surface of this has been touched at all, and of this not one-fourth of the dirt has been washed.

The mode of working was by sinking shafts about 4 feet in diameter, then seeking for the richest streaks, and washing only the dirt taken from these. The miners labored under serious disadvantages, which rendered it impossible for them to save money by their means of working, except by washing only the richer deposits, or "pay-streaks," as they termed them. There being no water nearer than the town, some two and a half miles distant from this placer, they were compelled to take advantage of any circumstances that would enable them to secure the necessary amount for their work. In the winter season, when there was snow on the mountain, they utilized this by melting it with heated stones, and thus managed to keep their washing holes supplied. When there was no snow, they were compelled to haul their water from the town, or purchase of those who made a business of hauling it, at $1.50 per barrel. When in addition to these difficulties it is understood that only the *batea* (a shallow wooden bowl) was used in the washing, it will be seen that the miners must indeed have worked rich deposits only, to realize even a poor subsistence. Many of them found nuggets of considerable value. The largest one reported is said to have been sold for $6,000. Señor Arauda states that he weighed one which went 11 pounds and 9 ounces avoirdupois. This was exchanged at $16 per ounce, as was all the gold at that time, although of fine quality and really worth $20.

That this cañon has hardly even been fairly prospected, is further evidenced by what Señor Arauda has done since the exodus of the miners generally from the mines. On a portion of the wash which had not previously been prospected at all, and at a considerable distance from the mountain, where very coarse gold was not expected, he sunk a shaft to the bed-rock—about 40 feet—which he worked with as good success as in his shafts in the old part of the diggings. From this shaft he took out from 50 to 100 buckets of pay-dirt daily, and realized from it between $200 and $300 per day for a considerable time. Even here he found nuggets, one of which brought him $600. He is one of the few who have continued to work in these placers.

The Bonanzita de los Granos is a fair representative of the placers around the Puerto. They have all been worked to a considerable extent with similar results. The gold is so far from being all taken away that even to this day the inhabitants keep up their old custom of turning out in a body, after every rain-storm, in search of such nuggets as may chance to be exposed by the rush of water through these cañons.

One of these placers, the Bonanza Viejo, extends into the valley beyond the line of the Cañon del Agua grant. This fact has been taken advantage of by a company of gentlemen of Santa Fé, to utilize the wash to their own advantage. The land being public, they have taken it by pre-emption, and are sinking an artesian well just outside the line, for the purpose of getting water to sluice their claim. They have thus far spent about $8,000, and sunk the well a trifle less than 300 feet, with a good promise of success. They have now about 60 feet of water, which by a pump affords a supply of about four barrels per hour. They have full confidence in ultimately obtaining a supply that will be equal to the capacity of the bore.*

What is peculiar to this placer is that rich float-quartz is largely mixed with the earth, and that it is from this that the largest part of the gold has been obtained.

In 1847, after the reduction of New Mexico by General Kearney, nearly all the miners left the placers, never to return. Why they left so suddenly, is somewhat conjectural. Probably a doubt of the pacific intentions of their new rulers toward them had no small influence in leading to their dispersion. Whatever may have been the cause, it is believed that, at the time, the mining operations of the locality were at their height of prosperity.

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*I do not share these sanguine expectations. My impression, formed upon a brief examination of the locality, is unfavorable to the hope of a large permanent supply from this well.—R. W. R.

Since that year but little has been done to revive the mining business in the neighborhood, and the once flourishing town has gone into decay.

These placers in the aggregate cover certainly not less than 800 acres of gold-bearing earth. These 800 acres, so far as can be ascertained, average in depth of gravel about 25 feet. In area and depth they are inferior to the great deposits of the old placers on the Ortiz Mine grant, which adjoins this grant on the north. In absolute richness they have perhaps proved superior.

The all-important drawback is the lack of water for sluicing, or even for simple washing. For the latter purpose a partial supply may be obtained, doubtless, by artesian wells, though not in such a way as to obviate the necessity of carrying the earth to the water or the water to the diggings. The best localities for wells would be topographically lower than a large part of the rich ground.

A plan has been suggested of connecting the placers by tramway with the nearest available stream—the San Pedro Creek, five and a half to nine miles distant from the various diggings, or the Rio Grande, twenty miles distant. This system has never to my knowledge been employed in extensive placer-mining, and I do not think it would pay. Mining would still have to be done by hand through shafts and drifts, and the handling and transportation of material would eat up the profits.

The only remaining method is the ordinary but in this case very costly one of bringing water upon the property by means of a ditch. What has been said on this point above, with relation to the old placers on the Ortiz mine grant, will apply here also. The new placers are several miles nearer, by the necessary route, to the point on the Pecos from which water should be taken to secure the necessary head. The construction of a single large ditch to supply both properties would undoubtedly be remunerative.

The lode mines.—In the trail leading up the mountain from the Bonanza del Cañon the outcroppings of several auriferous veins are plainly discernable. The Aranda lode, a considerable distance up the mountain, shows an excavation of some 30 feet into the side of the mountain, and has a shaft about 50 feet deep. Mr. Hargus, a resident of Real del San Francisco, has recently worked it with some success, the ore running from $16 to $20 per ton in the stamp-mill. The pay-vein is narrow, and the lode probably only a spur. Its course is northeast and southwest.

A few yards above the Aranda is the Brown lode, which has a shaft about 60 feet deep. This vein has the same course as the Aranda and the same peculiarities, having syenite walls and carrying free gold.

Following the course of these lodes a short distance over the spur of the mountain, into which they penetrate, we strike the noted Ramirez vein, which runs nearly north and south across the crest of the mountain. This deposit has been opened in five different places. The most southerly of these openings is the Ramirez mine, which was described by Mr. Brückner in my report published in 1870. There have been no important developments since that time. The vein is 25 feet wide, and carries decomposed iron-stained quartz and malachite, with free gold. In former times it was worked by the Mexicans, who dug four large caves into it, leaving pillars for support. Mr. George Brown subsequently opened it with an open cut about 50 feet long and 25 feet deep, showing a very regular stratum of brown and green color between parallel and well-defined walls. It lies nearly horizontal, its dip being only 10° southeast, (into the hill.) Six average samples taken from different parts of the vein prospected by Mr. Brückner, yielded from $10 to $20 gold per ton.

Several miles distant on the Ortiz mine grant I found in 1873 what appears to be a continuation or repetition of the same peculiar deposit.

About three-fourths of a mile east of the Ramirez mine is the San Miguel lode, which follows the crest of the spur of the mountain opposite the Cañon Bananza Viejo, and is clearly marked by the outcroppings on the surface for a long distance. A shaft has been sunk upon this lode to the depth of 30 feet, from which, I am informed, was taken a large quantity of very rich ore; specimens are still lying around the mouth of the shaft, on some of which gold is visible to the naked eye.

Many other openings on the mountain show indications of both gold and copper ore, but there are none that can properly be dignified with the title of mines. The remarkable richness of the gravel at the base of this mountain, the fact that the fragments, angular and not greatly water-worn, and the occurrence of abundant "float-quartz," all indicate the existence of numerous quartz-veins, but undoubtedly the placers are at present the most promising field of operations.

The San Pedro grant.—This grant is about nine miles in length and five and a half miles in width, with an "added league" about two and a half miles square, extending into the plains from its southeast corner, the whole containing 35,911$\frac{63}{100}$ acres. The grant is much diversified, embracing mountains, hills, valleys, and plains, and is suited to the purposes of mining, farming, milling, and grazing. On the easterly portion are the San Ysidro and San Pedro Mountains, and on the westerly the foot-hills of the Sandia; between these and the added league are plains covered with gramma grass, (the best known for stock,) the center of which are cut by the San Pedro Creek and several branches, the valleys of which embrace hundreds of acres of fine agricultural land.

Mines.—The only mines positively known on this tract are on and around the San Ysidro and San Pedro mountains. The canoñs of the former are said to contain good placer-diggings, and the mountain itself both copper and the precious metals, with indications of iron. General Palmer, in his Report of Surveys Across the Continent, (p. 137,) says that on the San Ysidro Mountain, in this district, there are numerous lodes of copper, as well as silver and gold, which were worked many years ago, before the memory of the oldest inhabitant, and that the ruins of numerous furnaces and arratras are to be seen. It is not unlikely that thorough prospecting might open here some valuable deposits.

After the conquest of New Mexico by the Spaniards a very large and profitable mining business was carried on in this region, the Indians who had been reduced to servitude being the unwilling operatives of the mines. But after the uprising of 1680, and the consequent expulsion of the Spaniards, the Indians, to secure themselves against a repetition of the oppressive labors which had been required of them, carefully covered over such mines as had been in recent operation, and, as far as possible, obliterated all traces of them.

Traces of these hidden mines are frequently discovered. Don Serafin Ramirez claimed to have found one on the San Pedro Mountain, but, I believe, carried with him to his grave the knowledge of its exact locality. When the survey of the grants was made, one of the party of surveyors discovered one on the line between the two grants, but a short distance from the Cañon del Agua Spring. He has never yet revealed its exact location, although he has offered to the proprietors to do so, and open it at his own expense, if they will secure him an interest in it. New

Mexico is full of traditions concerning these ancient mines, to which, of course, little faith can be given. The discovery of the filled-up and overgrown excavations unfortunately affords no guarantee of the value of the particular deposit found. Some of them were very profitable, but which?

At the southern extremity of the San Pedro Mountain a party of prospectors recently made the discovery of a silver-ledge, which they called the San Antonito. They at first supposed they had found two ledges, the western one of which they called the Robinson; but on excavating some 12 feet to find the west wall of the San Antonito, and finding none, they concluded that after all it was really but a single ledge. On the east side is a good wall, and also on the west of what was called the Robinson. At the east wall a pit has been sunk 10 feet, and shows a widening vein of galena-ore, now some 6 inches in width. Two assays are reported, one showing $40 and the other $80 to the ton. The vein-matter in the westerly portion, or Robinson lode, is of quite a different nature, and is said to indicate chloride of silver. I have not seen it. The lode has been traced by its outcroppings a considerable distance along the crest of the mountain. Other discoveries of silver-ore are reported on this grant, but I have no definite information in regard to them.

It is not certain that the coal-beds exposed on the Ortiz grant and along the Galisteo underlie at workable depths the San Pedro grant. Indications of iron-ore are abundant, but of this I can only say what I have said concerning the former region: it seems to me likely that the iron-ores showing themselves in veins will pass into auriferous pyrites in depth. But I do not speak of personal knowledge of the San Pedro grant. Timber is abundant, particularly in and around the Sandia foothills. The ranches and villages of San Pedro, Alimitos, Chimal, La Madera, and Palo Amarillo are mostly Mexican settlements of the poorer sort, and fallen to decay. Stock-raising and farming on a small scale, with and without irrigation, are the principal occupations. If building-stones were in demand, (as they are not at present,) excellent syenite and white and clouded marble could be obtained on the grant. But adobe is the fashion.

The Cerrillos.—This is a low, isolated range of mountains, about twenty miles southwesterly of Santa Fé, New Mexico, and about twelve miles east of the Rio Grande. The range covers an area of about four by six miles, the Galisteo River running along its southwesterly border. The formation is porphyry, syenite, with an occasional cropping of sandstone and limestone. The minerals contained are silver, copper, lead, iron, and coal. Gold has not yet been discovered in any amount worthy of notice, although extensive placers as well as veins of this mineral are worked a little to the south, on the Ortiz and New Placer grants. Mining in this locality has been mostly for silver and lead. I made a hasty trip to the Cerrillos in June, 1873, but did not see on that occasion the mines now considered most promising. I am indebted to Mr. Huggins for notes on them.

The Cerrillos, like other mountains in this region, are supposed to contain many rich mines, filled up and hidden by the Indians after the Spaniards were expelled in 1680. Twenty years elapsed before the Spanish authority was completely re-established here, and few of the earlier proprietors then returned. All records of their mining operations are lost. I have seen some of the ancient workings, but I was not particularly impressed with the wisdom of their location or the skill of their construction.

Recently, Dr. E. Andrews, of Santa Fé, having, with other gentlemen, obtained possession of all the known mines in the Cerillos, has re-opened two of them, and is now at work on one called the Santa Rosa, preparatory to extensive operations. He has a furnace erected on the Galisteo, to which he has already packed and worked several lots of the ore. The shaft, on re-opening, was found to be sunk 55 feet. The results of assays and smelting up to June 15, 1873, were as follows: Four assays from *débris*, respectively, 9 ozs., 12 dwts., 10 grs.; 18 ozs., 15 dwts., 15 grs.; 15 ozs., 5 grs.; 8 ozs., 15 dwts., 7 grs. Average: 13 ozs., 2 dwts. per ton of 2,000 lbs. = $15.90.

A small quantity of ore found at top of shaft was first worked in the furnace, producing bullion worth $92.58 per ton. On sinking the shaft to 65 feet Dr. A. made a run of fresh ore, obtaining $120 bullion. On sinking 10 feet further he obtained $132. This was the last run made up to the date given. The shaft was in June nearly 100 feet deep. After sinking it a few feet further, it was proposed to run levels and put the works into regular operation. The crevice between walls ranges from 5 to 6 feet. No mineral was found above a depth of 25 feet, where it appeared and gradually widened, until it attained a width of about 2 feet of argentiferous galena.

The Rueleña is the second mine spoken of as having been re-opened by Dr. Andrews. The opening is in a zigzag course, and extends to about the depth of 70 feet. Dr. A. has made twenty-five assays of samples found in the *débris*, the lowest of which ran $16.25, and the highest $227.60; the average being about $104 per ton. There are several old openings on this vein, in which considerable work seems to have been done; but they are all filled in. The vein can be traced by its outcroppings for a mile and a half.

From another mine, situated about two miles southeast of the last named, Dr. Andrews obtained a small quantity of ore, which he smelted, realizing from the bullion $72 per ton. The bullion in all these runs covers about 75 per cent. of the dressed ore from which it is obtained.

The mines of the Cañada de las Minas.—These are situated along a cañon of this name, signifying Glen of the Mines, in the foot-hills some two and a half miles southeast of the Santa Rosa.

The Mina del Tiro (Mine of a Shaft) is the principal of these. It is probable that no mine in New Mexico has been more extensively worked, yet no one knows, nor is it possible to ascertain, its full extent, except at considerable trouble and expense.

There are two shafts still open on the vein, and two that seem to have been filled. The crevice is 5 feet wide. The shaft, which seems to be the original or discovery-shaft, follows the crevice, dipping with it about 75° to the northwest. About 100 feet southwesterly of this is a vertical shaft, opened some 30 feet from the vein at the surface, but striking it at about the depth of 100 feet. At this depth the two shafts are connected by a level or drift which is reported to extend along the vein 300 feet. There are other levels and extensive chambers in the mine, but it is impossible to obtain definite information as to their extent. At the time of my visit the shafts were in too dangerous a condition to be entered, particularly in the absence of ladders.

It is said that this mine has been opened to the depth of 200 feet, but there is no other ground for such a statement than tradition. Whatever workings there may be below the long level are filled with water, and doubtless have been so ever since the abandonment of the mine. As there are remains of a canoe in the mine, it would appear that when the miners struck water, not having facilities for removing it, they ceased attempting to sink the shafts deeper, and from that time mined only above that point, using the canoe to convey them to the different chambers of the mine. With the use of modern appliances, such small amounts of water as collect here would be little hinderance to mining. The vein has clearly-defined syenitic walls, and the extensive excavations are proof that it has been found continuous in depth. The surface indications, also, in the broad and continuous outcroppings which can be traced for at least a third of a mile, corroborate this conclusion.

That work in this mine was stopped suddenly and in the midst of active operations (doubtless at the Indian uprising in 1680) is apparent from the circumstance that all the ore to be found in the *débris* of the mine is around the inclined shaft. The vertical shaft was evidently sunk long after the other, with the view of making it the working-shaft, as appears from its being commenced away from the vein and sunk vertically; yet it was apparently never used at all.

The pay-ore is argentiferous galena. It is next to impossible, without re-opening the mine, to obtain fair specimens of the ore, as everything worth picking up around the shaft seems to have been taken away. Assays of inferior samples from the *debris* have been made, ranging from $8 to $52 per ton. In appearance the ore is much the same as that of the Santa Rosa, and it will doubtless prove equally rich. So much labor would hardly have been expended on a mine carrying a low grade of ore. On the other hand, it must be remembered that in those days the value of the precious metals was relatively much greater than now, and that peon labor was but a trifling expense to the employer.

The two principal shafts of this mine are among the few in the country that have not been filled or caved in, and consequently are in condition to allow work to be commenced almost at once, and at a comparatively small expense.

There are no evidences of any extensive furnaces having been erected and operated in this neighborhood, although the remains of small ones are to be found on the Galisteo. According to Mexican and Indian tradition, the rich ores from this locality were packed on *burros* (asses) to Chihuahua, a distance of six hundred miles, for reduction.

Across a small ravine from the incline of the Mina del Tiro are the bold outcroppings of a nameless lode which crosses the line of the former at an angle of about 40°. This lode, though carrying galena at the very surface, is not opened at all above ground. It is at least 10 feet wide, and has every indication of being a valuable mine. But that it has not been worked by the shrewd old Spanish miners is not so certain. Its distance from the old shaft of the Mina del Tiro is so short that it could have been much more easily reached and opened from that than from its own surface; and this, in the opinion of those best acquainted with these mines, is what was done. A small sample from the outcroppings, on being assayed, produced $22.56 per ton.

On the west side of the cañada, a short distance below the Mina del Tiro, is another nameless lode, which has evidently been pretty largely developed. It has an opening diagonally into the side of the hill of about 20 feet, at the bottom of which are strong timbers placed over what appears to be a vertical shaft, and these covered with earth. This mine was apparently covered over for protection merely. The excavation at the surface not having been closed up, there was probably no intention to conceal it. Not a single sample of ore could be found in the *débris* outside. Some small pieces of carbonate ore were, however, obtained from the vein at the surface, which produced, on assay, $24.31 per ton. The width of the crevice between walls is from 5 to 6 feet.

The re-opening of this mine, as the covering has apparently been effectual in protecting it against earth and rubbish from above, could doubtless be done at a very light expense, the removal of the covering being probably all that will be required to expose the shaft and such excavations as there may be, in much the same condition as when the former operators ceased from their work, barring the decay and collapse of timbering.

On the opposite side of the cañada from the last-named is another ledge, which has an excavation of about 15 feet into the side-hill. But though it it is clearly defined, with a crevice full 7 feet wide, no ore appears to have been reached. The vein-matter, however, has much the same appearance as that of the others.

In the various ravines running into the Cañada de las Minas more or less "float ore" is found. When found here it is always argentiferous galena, and in nearly every case indicates a lode that has as yet been undeveloped, since the developed lodes in the locality are entirely in or near the banks of the cañada.

About three-fourths of a mile north-northeast of the Mina del Tiro are two considerable excavations, which present a very different appearance from the others examined. The ledge, if it be such, seems to carry copper rather than silver. A very rich, though narrow, copper vein runs through it, and no evidences of silver appear.

But more interesting than these excavations is an artificial curiosity, which lies near them, in the shape of a ruin of a circular building, about 10 feet in diameter, and which seems to have had the form of a section of a cone. The foundation-layer is undisturbed, while every stone above that has been thrown into the space inclosed. The earth at the center of the circle is considerably depressed, and its appearance suggests that a shaft had been sunk there, and that the structure had been erected for a shaft-house. If this conjecture is correct, the mine, when operations ceased, was probably filled with the surrounding vein matter, and the walls of the building thrown upon it, to conceal it more effectually from observation. On these grounds, it is thought by some that this was probably the main mine of the locality, and the other excavations mere experiments, perhaps, to discover the exact position of the ledge. As I did not visit this spot myself, I have no opinion on the subject. But I cannot see the need or use of a shaft-house of such a shape and only 10 feet in diameter.

About 100 yards south of this point, on the crest of the same hill, is a hole, now nearly filled, showing in the *débris* a considerable quantity of copper-ore of a good quality. This is very unlike that from the other excavations, and probably is from a different vein. A blow-pipe test showed from 20 to 25 per cent. of pure copper. There is every indication that a large body of copper-ore is to be found in this locality, and the reason that work was not further pursued here by the Spaniards was, probably, that they sought silver, not copper.

Iron.—At several points among these hills are large indications of hematite iron. Not a pick, however, has been struck into them, as an iron-mine in this region is not deemed of any value. This mineral, indeed, crops out in all parts of Santa Fé County, but scarcely a ledge has been opened, and not an iron-furnace has been built. This condition of things will doubtless change when the expected railroads arrive in the neighborhood.

There are extensive outcrops of shale in this range, similar in general appearance to that which accompanies the lignites of the region; but I found no coal, though I examined several promising localities.

The Galisteo River washes the foot of these hills, and supplies an abundance of water for running any desired amount of machinery by steam during all seasons of the year. From the Mina del Tiro down the Cañada to the river is a trifle over a mile, by way of which a good road can be constructed at a small expense. With the exception of a few small springs, there is no other water in the locality.

The only woods worth mentioning are piñon and cedar, of which there is a considerable supply. They are of small growth, but excellent for fuel.

There are good roads connecting the Cerrillos with all important neighboring localities, and the mines are easily approachable, either from the north or south.

In my report published in 1870, this property is alluded to as belonging to the grant owned by the Delgado family, and known as the "Cerrillos grant." This, I am assured, was an error. The Delgado claim names "high hills" as the *southern* boundary of the grant. Sierra Cochilla Piedrigoso is the most southerly of the hills clearly referred to; and this is nearly a mile north of the mines on the Cañada de las Minas. South of this there are no "high hills" short of the Old Placer Mountains, and these are in the midst of another grant, and some six miles south of the Galisteo River.

The error doubtless arose from the fact that what are now known as the Cerrillos (which means small mountains) are not the hills originally known by that name, but have acquired the name from their vicinity to the old Cerrillos, and the fact that the Spanish word in some measure describes them. The original Cerrillos lie some four miles north of the others, and are the hills that gave the name to the grant. In corroboration of this are the facts that the creek just south of these hills bears the same name, and the ranch nearest them on the creek is called the "Cerrillos Viejo Ranch," (the old Cerrillos Ranch.) These facts are well understood in the neighborhood, and the Government officials, having full knowledge of the circumstances, did not hesitate to issue patents for these lands in fee-simple, and without reservation, to the present owners.

Railroad communication.—The Atlantic and Pacific Railroad Company has located its road through this immediate section; and what is known as the line of the Galisteo is not only recognized generally as the most practicable route, but is adopted by the company, and the public lands within its limits have been withdrawn from the market.

But it is most likely that, before this company will be able to extend its road to this section, the road of the Arkansas Valley and Cimmaron Railway Company, which has been organized for the purpose of continuing the line of the Atchison, Topeka and Santa Fé Railroad from Fort Lyon, via Cimmaron and Fort Union, to the Rio Grande at Albuquerque, will have been constructed, and the railroad connection between the east and the Rio Grande accomplished. The president of this company states that the Galisteo is already determined on as the route of his road.

The Denver and Rio Grande Railroad (narrow gauge) is also in course of constructions toward the same objective point, it having already passed Pueblo, and being pressed toward Trinidad. Two routes for this road have been in contemplation. One passes, via the Sangre de Cristo Pass, to the Rio Grande; thence along that river to a point in the neighborhood of San Juan; thence to Santa Fé; thence southwesterly to the Galisteo just below the Cerrillos, and thence again to the Rio Grande, and down the river to Albuquerque. The other passes, via Trinidad, the Raton Pass, Cimmaron, Fort Union, and the Galisteo. The latter route has been adopted, and grading has been carried on in the direction of Trinidad. The distance by this route, from Pueblo to Santa Fé, is three hundred miles.

From these facts it would seem that no less than three railroad-lines are likely to pass through this section, and that one or more of them will reach the Cerrillos.

THE TURQUQISE MINE.

Farther north than the Cerrillos range there are large hills of what appears to be trachyte, and in one of these occurs a very interesting ancient excavation, known as the Turquoise mine. It comprises two enormous open quarries, perhaps 200 feet in depth at the deepest point, and covering an area of several acres. They must have been produced with great labor, since there are no traces anywhere of the use of tools or gunpowder. Tradition refers these workings to a period of greater antiquity than the Spanish occupation, and declares them to have been executed by the Aztec inhabitants of the regions who preceded the present Indian races. I am informed that stone hammers have been found in these quarries, but no tools of any metal. It seems at first incredible that excavations so extensive could have been made by means so rude and simple; but a careful examination of the locality convinced me that the achievement would not be impracticable. The trachyte is seamed and fissured throughout, at small intervals, and in every direction; and there is no reason to doubt that hammers, wedges, and levers would be quite sufficient to remove the solid masses. The torquoise occurs fully in the fissures, in the form of narrow seams and plates, rarely or never exceeding the fraction of an inch in thickness. The majority of the seams now exposed show the impure green variety, which is worthless. The present Pueblo Indians, like civilized people, value the light-blue turquoise only. Upon this they set a high price, being willing, as I am informed, to barter a pony for a specimen of good color and uniform texture, large enough to be pierced for a necklace. The visitor to this locality seldom fails to find a few bucks or squaws squatting upon the heaps of *debris*, and diligently searching for small fragments of blue turquoise; but they appear never to have conceived an idea of continuing the excavation. Indeed, they seem to have that aversion for mining labor which the Indians of New Mexico have probably inherited from the days of Spanish tyranny, when they were forced to work as peons in the mine. When questioned on the subject, they declare that this mine was worked by a race of Indians now departed.

SOUTHWESTERN MINING DISTRICTS.

During my visit to New Mexico, I made arrangements for full reports from competent residents concerning the mining regions of the southwest, Silver City, Socorro, &c. I regret to say that these reports have not been received in time for the present report; and the distance and difficulty of communication have made it impracticable for me at the last moment to fully supply the omission. All these districts are still in the opening stages of development. Silver City may be said to have got fairly started, having several mills at work; but there were last summer no deep mines open; and the supplies of ore were from comparatively shallow workings. Mr. Burlingame, formerly territorial assayer at Central City, Colo., was in charge of a fine mill, containing Brückner cylinders for roasting, and was reported to be running it succesfully.

Prof. N. H. Winchell, director of the geological survey of Minnesota, has put at my disposal his notes on Southwestern New Mexico, obtained in 1872 by personal examination; and, although the period which has since elapsed has been one of considerable activity in mining in that region, and hence this description may not do complete justice to the resources of the region as now known, yet the high authority of the observations, and the circumstance that they have never yet been published, together with the failure of my recent attempt to obtain late and trustworthy information, lead me to incorporate them in the present report.

The mines visited by Professor Winchell comprised certain copper-claims in the northern foot-hills of the Burro Mountains, the Santa Rita copper-mines, the Lone Mountain silver-mining district, the Silver Flat mining-district, the Chloride silver-mining district, and the Piños Altos gold-mining district.

The foregoing silver-mining districts are situated in close proximity to each other, and in Grant County. The Chloride and the Silver Flat districts are near Silver City, which is about eight miles nearly west from Fort Bayard. The Lone Mountain district is about eight miles south-east from Silver City.

Copper.—The Venus Lead, so called, is situated about five miles from the foot of the principal hills of the Burro Mountains, and in one of the northern foot-hills of that range. The country rock is an imperfect prophyry. The feldspar crystals are white but rather small; the quartz is in scattered grains; and the third ingredient is a soft green mineral, the external characters of which resemble those of chlorite. The whole readily decomposes and is easily excavated to great depth. Openings have been made at a number of places, supposed to be on the same lead. The principal excavation is known as the Venus mine, but it was only 15 feet in perpendicular depth. The chief deposit of ore, so far as disclosed by the work done in 1872, is the carbonate of copper, of which some very fine and large pieces have been obtained. There is also more or less chrysocolla. The whole is accompanied with considerable magnetite. At some of the other openings in an east or northeast direction from the Venus mine, supposed by the owners to be on the same lead, the ores comprise, besides those named, copper pyrite and azurite. At some of these points the surface indications are much better than at the Venus itself. The sum of Professor Winchell's observations on this location resulted in the following general conclusion: A series of quartz veins, about a foot each, some very well marked for copper and others having none, cross the hill on which the principal opening is made, in a direction northeast and southwest nearly parallel, sloping or dipping to the southeast. They are spread over a surface of about 100 feet laterally, so far as yet developed, and would be best exposed by cross-tunneling in a direction southeast or northwest through the hill. Some of these veins are traceable on to the adjoining hill northeast. The effect of these copper-bearing veins on the inclosing rock has been to disseminate their contents, particularly the carbonate of copper, through the whole mass contiguous, and hence the green carbonate is found in all natural partings and cleavage planes where it could accumulate.

Another cupriferous vein crosses a hill a short distance southeast from that in which the Venus is situated, and is known as the Amsterdam lead. It has been but very little explored, its thickness not being more than 4 to 6 inches, so far as ascertainable from the development made. This deposit has an anomalous character. It seems to be destitute of real quartz. It consists rather of a series of irregular accumulations in the cleavage planes of the syenite. It is not constantly in one vein, but spreads and branches in various directions, apparently following the natural openings in the rock. This ore is said to assay by blow-pipe examination a considerable amount of silver, but tests which I have been able to make have not disclosed any silver. The copper-ores consist of the green carbonate, some chrysocolla, and cholcopyrites. There is also a large per cent. of iron. This ore of iron appears like magnetite, but my examinations indicate rather an uncertain mechanical mixture of the proto and sesqui oxides of iron.

Two and a half miles southeast of the Venus lead is the San Antonio location. This appears on a hill about 500 feet above the adjoining arroyos. In approaching it from the northwest it shows at a distance a conspicuous mass of greenish rock projecting out of the summit of the general mass of the hill. On a near approach it appears to be a crumbling syenite, which can be easily excavated, like the rock of the Venus mine. It parts under the weather into angular blocks of 1 inch to 6 inches in diameter. On these natural divisions or planes, which run in all directions, there is usually a scale of green carbonate of copper, varying in thickness from the merest film or coloration to half an inch. From the fact that the action of the weather only separates the rock along these planes the exposed face of the bluff looks very green, and seems to indicate a great mass of green copper-ore, but on making a fracture through the rock, independent of the natural parting, it shows the syenite only. There is no distinct system of veins, and the only guide in mining or developing the ore will be the jointing system of the syenite rock, which indeed is complex and various. Yet it may be said that the principal jointing system of the mass runs in a direction about north and south, sloping or dipping at an angle of about 45° to the east. Various other systems cross this at different angles, separating the whole hill into angular blocks of various sizes and shapes. These planes of separation are the places of deposit of the copper-ore, although it sometimes embraces continuous beds that have much the appearance of veins. The planes of the principal system of joints, at least that which bears the most conspicuous amount of copper-ore, are about 20 feet apart. I saw two such planes, containing ore from 1 inch to 2 inches in thickness. Sometimes the ore in these planes widens out to 3 inches in thickness, but soon "pinches" back to 1 or 2. There is also a light stain of copper disseminated through the entire mass of the rock. The only work here done is in the form of a tunnel that enters the side of the hill about 60 feet below the summit, intersecting a net-work of thin copper films and scales. This ore is so mingled with the mass of the rock that none of the part excavated has been deemed worth preservation. The location, however, of the tunnel and its direction are unfavorable for developing the ore in its principal deposits. It runs nearly parallel with the principal system of joints. The highest estimate that can be made of the per cent. of copper-ore compared, bulk for bulk, with the rock necessarily excavated and handled over to obtain it, is one five-hundredth part.

The country round about the Venus, the Amsterdam, and San Antonio locations, is hilly, or rolling, with the same kind of syenite knobs, and although there is usually a thin soil derivable from the disintegration of the rock *in situ*, so as to conceal the mineral contents of the rocks from sight, and supporting more or less of the mountain shrubs or grasses, the trees of the country are stunted and low-branched; they occur without the frequency of trees in the well-known "oak openings" of Michigan. They consist of pine and oak, with some cedar. The pines are sometimes 18 to 20 inches in diameter at the base, but rarely over a foot. They sometimes rise 25 feet without important branches, but the most of them are branched more or less to the ground. The oaks especially are low-branched and spreading. The cedar is often a large tree of 2 feet in diameter, and has a sound trunk for 10 or 20 feet, but it is also apt to be branched even from the ground, and divided into two or more trunks.

The only reliable water available for milling in the vicinity of the Venus and San Antonio leads is southwest from the Venus. Here a spring of water is disclosed in a narrow, marshy place, situated between two syenitic hills. At the time of my visit it was not copious, nor did it produce a continuous stream, but had to be kept cleaned out to produce drinking-water. In the wet season a surface stream runs from this swale, as evinced by an arroyo farther down. About 60 yards farther still, a small surface stream occasionally appears in this arroyo. Streams in New Mexico often disappear below the surface, for several miles, or entirely evaporate. In the former case they sometimes spring out afresh at points farther down, where a rocky bed forces them to the surface of the ground, or in the wet season become rushing and devastating torrents. Hence, it is very probable that a little excavation in this arroyo below the point where the spring now exists, would discover, even in the dry months of the year, sufficient water for running a steam engine.

Besides this there is, during several months of the year, a stream of water carrying nearly 200 inches running within half a mile of the San Antonio location.

The Santa Rita copper-mines are east from Silver City fifteen miles. A bluff of ejected trap-rock strikes across the country southeasterly, presenting a perpendicular wall from five to eight hundred feet high above the general level, facing to the northeast. This wall is a conspicuous landmark for a great many miles, being visible from the Burro Mountains, a distance of twenty miles. Its northwest termination is abrupt, and is marked by the singular perpendicular column known as the Kneeling Virgin, owing to the resemblance it bears to a draped female figure kneeling before an altar. The Santa Rita mines are two and a half miles farther northwest. The rock here inclosing the ore is the same as that of the San Antonio in the Burro Mountains—a whitening, crumbling, syenitic porphyry, in which the hornblende is replaced by chlorite. (?) The ore also is similarly disseminated through the mass, there being no true veins, not even a trace of quartz visible to the unaided eye. Chemical tests alone disclose in those parts most decomposed a considerable per cent. of silica. The planes of jointing hold the ore. The most of it is green carbonate of copper or malachite, but within this carbonate, which occurs in irregular nodular courses, is usually a central band of the average thickness of three-quarters of an inch, of a reddish-gray copper-ore, which has a cherry-red streak, and tarnishes superficially to a charcoal black after long exposure, especially within the mine. This I take to be essentially red oxide of copper. It embraces frequently small deposits of native copper, and is associated with more or less impure chrysocolla. In some places at the Santa Rita this last-named ore was seen to comprise the greater portion of the central band already mentioned as embraced within the green carbonate. I judge that between one and two hundredths, bulk for bulk, of the rock taken from the mine is copper-ore. The mode of occurrence is precisely the same as at the San Antonio. In order to get the ore it is necessary to remove the entire mass of the rock, which is everywhere permeated with the carbonate, and carefully select the best. The thickest masses are about 3 inches, but are of short extension. The mine is now opened to the depth of 100 or 150 feet, and consists of an irregular net-work of tunnels, which ramify underground in all directions, guided only by the indications of ore. Occasionally columns for the support of the superincumbent rock are left standing by the miners.

From Mr. James Fresh, who last superintended the working of the mine, the following particulars were derived:

No ore was worked that did not yield 50 per cent. For taking the ore out Mexican labor was employed. The men worked in the simplest way, picking the rock to pieces in the mine, and carrying it on their backs up the almost perpendicular ladders. They were obliged, for 1 cent per pound of the ore they produced, to bring it to the surface of the ground, as well as remove all refuse rock from the mine and dump it at places designated. Two men usually worked in company, one to excavate the rock and one to carry it out. The two would take out an average of 300 pounds per day. Some men, especially Americans, would take out 1,000 or 1,500 pounds; others not more than 50. They were allotted to certain places where they must work. A sort of white rock obtained in the mine, which has a slippery, talcose feel, containing some carbonate of copper, is used for flux in reducing the harder ore of the mine. There is said to be enough of this to smelt all the hard ore, the carbonate contained within it paying for working it. It is denominated "talc" by Mr. Fresh. I have not ascertained its chemical composition, but am satisfied it is not pure talc. It probably contains lime and silica, with some soda and magnesia, the alkaline constituents giving it its fluxing quality. The present owners are Sweet & La Cost, of San Antonio, Texas, Alexander Brand, agent, Albuquerque, New Mexico, and James Fresh, superintendent, Silver City, New Mexico. It is generally admitted that the mine was included in an old Spanish grant, and by that title is now, or was recently, held by a widow lady now living in Spain, her agent being in Old Mexico. If she has any agent, he has made no appearance on the ground within the last fifty years. Mr. Willey, a lawyer, claims to have searched out this old title, and to have bought the mine of the heirs of the Spanish lady. He is making efforts to obtain a United States title, and is said to intend working the mine. Work on the mine, Mr. Fresh said, was last abandoned because by the methods employed it was not found to be profitable. They used a small Mexican blast furnace.

Near this mine is a fine constant stream of water, which would answer all purposes of milling. Wood, also, of about the same kinds as already mentioned in connection with the Venus and San Antonio leads, can be obtained in the neighborhood. Mexicans carry it into Silver City for $2.50 per cord, cutting it wherever they can most conveniently.

It is quite likely that other locations could be made in the immediate vicinity of the Santa Rita that would prove equally good. The hills about are low. There is a great similarity in the rock, and it may be presumed that it carries the green carbonate and red oxide in the same manner as developed in the Santa Rita.

Silver.—In the Lone Mountain silver-mining district the mode of occurrence of the silver-ores is the same as at the Silver Flat district, and as the information obtained will not warrant me in presuming to give a complete account of each, they may be included in one general description. In this description the Chloride silver-mining district may be partially included, although on the flat at Chloride the ores occur in an exceptional manner, and will need special description.

In each of these districts there are a great many separate locations owned by different parties, the several merits of which Professor Winchell had no time to investigate. But from what he saw he became convinced that there is good reason for predicting a rapid development of these districts on their own merits. The silver occurs in or associated with a metamorphic limestone, which is probably of the carboniferous age. A belt of low hills, only one side of which is usually of limestone dipping with the slope of the hill, runs east and west, extend from the Gila River, perhaps from some point farther west, an unknown distance easterly, including the Chloride, Silver Flat, and Lone Mountain silver-mining districts. It seems to taper to a point toward the Gila, and also below Lone Mountain, covering a distance of thirty-five or forty miles, having a width of about four miles. On either side of this belt of limestone hills are granite hills. The limestone lies, wherever he was able to make examination, immediately on the granite, which is uniformly decomposed to a great depth, becoming more or less perfectly kaolinized. This limestone, instead of being entirely on one side of the hills, sometimes caps the hills, descending equally on different sides, granite occurring round the bases. The metal is most frequently on the east side or the northeast, and well toward the flat or foot of the hill. The eastern slopes contain the limestone farther toward the valleys than the western. The ores are the chloride of silver, the sulphurets of silver and lead, and native silver. There is also a great quantity of iron-ore. While there are some true leads of quartz carrying silver ore, traceable for several thousand feet, at all these districts, the most frequent occurrence of the ore is in detached and irregular patches or pockets. This is true particularly of the chloride. Sometimes a complete network of fine veins is found to be rich in silver-ore. This irregular manner of occurrence of these ores in these districts has induced a change from the usual method of making locations at the Chloride district. Instead of locating on a lead in linear feet, the claims are taken as squares or blocks, 50 feet wide by 100 feet long. At the Lone Mountain and the Silver Flat districts the miners insist that their locations are on continuous quartz veins, and from occasional croppings, which seem to occur on all hands very irregularly, they fancy they can trace their leads over the surface. They have usually done very little work on their locations beyond that necessary to hold their claims. Several Spanish arrastras are in operation at Silver City, reducing by the amalgamating process the ores of the Silver Flat and the Chloride districts, the ore from the latter place being carried to Silver City, a distance of two miles, in order to reach water. Arrastras are also at work at the Lone Mountain district, on ores taken out there. The Mexicans also have smelting-works of an inferior kind established at Silver City for reducing the more refractory ores, such as argentiferous galena. They obtain their ore generally by theft from the various openings that have been made, not a location being owned by them. In addition to these cheap methods for reducing the ores of these districts, one or two good steam-mills have been erected during the past year, by which the ores of the Chloride and the Silver Flat districts will soon be more perfectly and more cheaply reduced. Mr. Coleman, the owner of the first mill completed and in operation, owns important interests in the Chloride district, but is more than occupied with the reduction of ores from other locations. His being the only mill in working condition, he is pressed with custom-work. Many of the miners have taken out ore, and are compelled to keep it in store till facilities for reduction can be had. Meantime, being generally poor men, they reduce by the simplest methods such quantities as will furnish their daily subsistence. At Lone Mountain also arrangements had already been made early in 1872 for the erection of a 10-stamp mill, by McIntosh & Hackney, a firm known as the Lone Mountain Mining Company.

The water at Silver City is not very abundant. At Lone Mountain, although there is not abundant surface-water, a good supply is obtained by sinking wells and opening ditches. Some parts of the year there is abundant water at both these places.

The following minutes from Professor Winchell's note-book, gathered hastily as he passed over the ground, will convey a better idea of these districts, perhaps, than could be given in any other way, although the statements of the miners concerning the yield of their locations must always be taken *cum grano salis.* These minutes pertain only to such locations as Professor Winchell happened to meet with, or to those to which his guides took him. There are many others, the names of which even he could not ascertain, which may be as good as those named. He does not wish to be understood as expressing a decided opinion on the merits of many of these claims, compared with others. These notes express the truth as nearly as he was able to obtain it, both in respect to the aspect of the various locations, and the yield they severally afford.

1. *In the Lone Mountain district.*—The Home Ticket, owned by Frost & Co.: vein about 25 inches, in limestone, shows silver glance, horn-silver, and a little native silver; direction about north and south; opening about 6 feet; gray ore, said on rough assay to run $2,000 per ton; traceable 4,000 feet.

The Home Ticket, first extension, opening 5 feet deep; vein 18 inches; one wall-rock well defined; somewhat scattered otherwise; vein here seems a brecciated injected conglomerate, with some quartz and considerable calc-spar; ore chloride and native silver; eight days' work by three men is said to have produced eight tons of ore; vein traceable 4,000 feet. George A. Allen & Co., of Fort Bayard, owners.

The Silver Tree: owned by Frost & Co., (nine partners;) thin veins scattered over a space of 4 or 5 feet, some 6 inches thick; excavation about 4 feet; in limestone, veins not well defined; general direction east and west.

The Relief: owned by George Warren & Co.; horn-silver and native; a value of $1,500 taken out of a hole two rods long and about 4 feet deep. Vein in limestone, about 6 inches wide; said to be one of the richest veins yet discovered.

The Twilight: between 5 and 6 feet wide, same rock and form; shaft 20 feet; traceable half a mile; owners, Stearns & Reisen.

The Far West: three feet wide; $200 per ton, owned by Frost & Co.

The Copper Point: comprises several leads; one chunk of 500 pounds said to be nearly pure platanea; owners, Markham & Co.

The Calumet: $16,000 per ton, (selected sample,) goes $1 per pound in the arrastra; owners, McIntosh & Hackney.

Shook and Tisions Mine: twenty-foot shaft; assays $5.

There were many others not seen by me. This district is not yet fully prospected.

Also the following were seen at Lone Mountain:

The Durango: vein 3 feet average, in the 1,200 feet owned; traceable about two miles; shaft 6 feet; owners, McIntosh & Hackney.

The Humbug: traceable about a mile; vein 4 feet in limestone; shaft 28 feet; on the vein only 6 feet.

The Mohawk: vein, about 2 feet average; traceable one mile; runs northeast and southwest; shaft, 5 feet; limestone walls; owners, Lone Mountain Mining Company.

The Rosario affords fine ore; vein, 4 feet; shaft, 8 feet; limestone walls; contains some of the best ore; owned by the Lone Mountain Mining Company.

The Saint Louis: vein, 2 feet; shaft, 6 feet; runs in about the same direction as the last; owners, Lone Mountain Mining Company.

The Big Emma: vein, 4 feet at 22 feet depth, with one wall-rock well defined; the other is less regular; it is in limestone. First ore worked at this place was amalgamated by Coleman, at Silver City, worked on halves, and was said by the owners to have given at the rate of 128 ounces retort to the ton. The foreman at the mill, when I subsequently interrogated on the subject, said it produced at the rate of 54 pounds from 8 tons.

In the arrastra process nothing under $200-ore will pay working, according to the statements of owners.* Six animals' expense is counted equal to that of one engine. Two arrastras and one pan will reduce 1½ tons of ore per week. In the process salt and mercury are used. Salt is obtained from the vicinity of Santa Fé, and also from different places east of the Rio Grande. At Silver City it costs $3.50 or $4 per hundred. Mercury at Silver City is worth $1.40 to $1.60 per pound. One hundred or one hundred and fifty pounds are needed for each barrel or amalgamator. Loss is about 1½ pounds per ton of ore. Mr. Coleman receives from 20 to 30 ounces of silver per ton for custom-work, the black ores running higher than others. Unrefined silver passes at Silver City for a dollar per ounce.

2. *In the Silver Flat district.*—The Eclipse Tunnel, owned by the Eclipse Tunnel Company, is the most extensive piece of mining-work yet done in the district. This tunnel runs a little south of west, and is intended to cut leads in the hill south and west of Silver City. It has a perpendicular cross-section of 6 feet, and a horizontal one of 5 feet. It is now drifted in 128 feet; work suspended for lack of funds. It begins in the common crumbling feldspathic porphyry of the country, and continues so about 65 feet. Then it strikes a siliceous, dark-colored limestone, which is the same as the stone of the Silver Flat district. Jasper bands cross it. It sometimes shows fossil shells. At the depth of 65 feet, between the porphyry and the limestone, is a quartz lead of 2 feet, cut by the tunnel. It is said to have contained some silver. There is also a thin casing or deposit of the porphyry on the limestone side of the lead. This, however, is said not to be constant, the lead really being embraced between the two kinds of work. Just on the brow of the hill above this tunnel is a 15-foot shaft, on a lead of 10 inches, supposed to be a spur or part of the main lead of 18 inches which runs parallel, or nearly so, with it, both together called the Braham lodes. There are three others of these lodes, which are to be cut by the tunnel. The tunnel company have the right, also, to all other leads cut which may not have been located at the time these were. The claim on each lead is 1.200 feet—600 feet each side of the tunnel. After passing the present claims of the company, 500 feet are allowed by congressional law on other leads. The lead seems to be loaded with iron-ore, yet, doubtless, would develop silver at a short depth. Many

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* This is an extraordinary statement, which I am at a loss to understand.—R. W. R

of the leads in the Silver Flat district are characterized by a heavy, earthy iron ore, essentially true magnetite, with very feeble magnetic power. This iron-ore, sometimes mistaken for sulphuret of silver, is said not to prevail at great depths, but that the experience of the deeper shafts has been that the leads pass into calc spar and quartz carrying various ores of silver. This iron-ore is earthy and usually amorphous, soiling the fingers. The prevailing color it jet black, but it is also sometimes tinged with red. These Braham lodes run in a direction northeast and southwest—at least, so the claim is defined.

The Robt. E. Lee: owned by the Lee Company; shaft, 35 feet; lead, 4 feet; with various quartz, feldspar, magnetite, and chloride of silver; situated near the tunnel on Mineral Point; claim 1,000 feet; direction about the same as others, northeast and southwest, more nearly north and south.

The Twin: owned by the Silver Flat Mining Company; claim 1,800 feet; very conspicuous vein, running about northeast and southwest; this is the original location of the Silver Flat district, made by the Bullard Company, eight in number; lead about eight feet wide.

The Legal Tender: owned by the Silver Flat Mining Company; situated near the Twin lode; shaft, 45 feet deep; vein, 4 feet at the bottom; ore and gangue similar to the Robt. E. Lee; said to be the "champion mine" of the country; one of the first discoveries. This company also own monster croppings, named Eutah, Twin No. 2, and a part of the New Issue claim in the immediate vicinity.

The Little Giant is farther northwest from Twin No. 2; owned by Milby & Co.; vein of 20 feet; more or less quartz and ore. It is a smelting ore, with little waste apparently, but of a low grade. It is 15 rods from the Great Eutah lead; shaft 20 feet, and a cross-cut 6 feet deep.

The New Issue is a vein of irregular shape and width, from 5 feet to 15; mean direction, south-southwest and north-northeast; excavation to the depth of 12 or 15 feet, irregularly over the lead. A tunnel is begun on the north side of the hill, intended to cut the New Issue; entered about 25 feet.

The Mother lead is owned by Hammond, Read & Milby, of Silver City. It is a conspicuous vein of quartz, running in a direction northwest and southeast, and is traceable for a mile. In that distance several claims are located on it. It is said to be 70 feet wide, but it is not satisfactorily opened so as to reveal its width or its mineral character. It is taken up and named, on the supposition that it is the *mother-vein* of the country from which the ores of the Silver Flat and the Chloride districts are derived. It is admitted to be a low-grade ore, although it is stated that ore taken from the depth of 8 feet, afforded at the rate of $30 per ton; assayed by Whitehill & Tidwell, of Silver City, by the arrastra process; claim of the above parties is 1,800 feet; shaft, 8 feet. This lead runs across the low ground intervening between the Silver Flat and Chloride districts, and well on to the hills on which many of the locations of both districts are made, crossing all the other so called leads, and acting as an independent system of fracture.

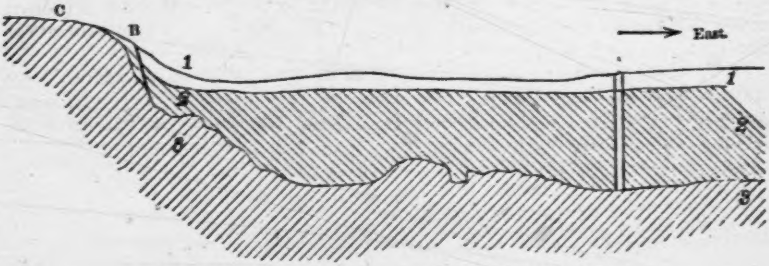
The Laura lode and mine are owned by Braham, Foster & Chandler; vein, 10 to 12 feet wide; quartz, with various ores of silver, some copper and iron; considerable waste-rock on the top; shaft about 8 feet; said to assay $100 to $300 per ton.

3. *In the Chloride district.*—The Lily mine shows a vein running east and west, of an average width of 15 inches; ore very good; argentife-

ous galena, chloride, and some native; claim 800 feet long, 100 feet wide; owned by R. B. and J. R. Metcalf.

The Two Ikes: owned by Coleman & Stearns. This mine is located by squares. It shows an irregular and altogether new manner of occurrence for silver-ores. The principal ore obtained is a chloride, but argentiferous galena and native silver also occur. The following sketch may show the superposition of the various rocks connected with this location, and the relation of the mine to them, as well as the situation of the principal deposits of ore.

CHLORIDE SILVER-MINING DISTRICT.



A, shaft, 31 feet; B, Two Ikes ledge; C, limestone hill.

No. 1 is soil and mixed drift; 4 feet.

No. 2 is a reddish and variegated shale. When powdered and well mixed the color of the mixture is drab. It is in regular layers, but is easily excavated. The strata are nonconformable both with the drift and with the limestone below; 4 to 30 feet.

No. 3 is a metamorphic limestone, in which occur the most of the ores already described, and all the locations mentioned at Lone Mountain and Silver Flat, and the most of those of the Chloride district. The upper surface of this limestone, where it is seen overlain by No. 2, is very rough and rounded angular, with sudden prominences and depressions. Farther up the hill-side, where the shale does not cover it, the limestone shows carboniferous fossils, but it is generally highly metamorphic, the bedding, even, being destroyed. It has numerous joints separating it into cuboidal masses. These joints are often the places of deposit of the ores of iron and silver. Thickness unknown, but from 50 to 100 feet. Underlying this is the feldspathic porphyry of the country already described.

The Two Ikes mine is situated at the foot of the hill, and near the place where the shale first appears overlying the limestone. A shallow sloping shaft or tunnel has been sunk through the shale, and then follows the limestone surface. The ore is found in irregular patches and masses, occupying the depressions in the surface of the limestone. They vary from 4 inches to 2 and 3 feet in thickness. The ore is principally the chloride of silver, with gangue rock of calc-spar. It is easily crushed and reduced. Sometimes these deposits are followed to some depth in the limestone below, where blasting becomes necessary.

The Texas is owned by Pearce & Metcalfe, and is one of the most extensive openings in the district.

The Sieneca, owned by Breman & Whitehill, is largely worked.

The King's Own goes through 3 feet of limestone before getting the ore.

The Providentia is also extensively opened. It is owned by Col. J. F. Bennett, I. N. Carrasco, J. R. Johnson, and others. It is located in the limestone on the side of the hill. These parties are confident the ore runs in a northeast and southwest direction, or more nearly north and south, and show three large openings, said to be on three separate large veins. The Providentia lead, at the principal place opened, is claimed to develop a thickness of 30 feet, and in reality the ore does occur irregularly over that whole interval. It will probably also be found in the same way if they should continue to excavate over the width of twice 30 feet, or to an unknown extent; this is owing, as already said, to the usual pockety or isolated manner of deposit. Mr. Johnson told me that a quantity of ore from the Providentia was sent East for smelting, the amount being 1,900 pounds. It was reduced at Newark, N. J., and returned a clear profit (net) of $752.55.

The Irving mine is in the limestone, in the flat; shaft, 18 feet; vein said to be 6 or 12 feet wide; not defined. The ore here seems to occur promiscuously in the joints and pockets of the rock; owned by Wm. Irving, Silver City.

CHAPTER VIII.

ARIZONA.

My information in regard to some parts of this Territory is very meager. As usual, I am indebted to John Wasson, surveyor-general of the Territory, for notes from different parts of the country. This gentleman had the assistance of Messrs. A. J. Finlay, F. H. Goodwin, and E. M. Pearce, of Arizona.

In Yuma County several of the older mines in Castle Dome district have been worked, and one or two new discoveries of very rich argentiferous galena are reported. Much money is reported to have been expended in this district during the year in explorations. The shipments of galena by the Colorado Steam Navigation Company during 1873 were 270 tons, by far the greater part of which came from Castle Dome. The silver value of this ore in San Francisco was about $75 per ton. Mr. Wm. P. Miller, a mine-owner in Castle Dome, has endeavored to raise capital in San Francisco, for the purpose of erecting smelting-works in the district. It is recently reported that he has had success, and that the works will soon be commenced.

The Sonoita mining district was organized in April, 1873. About $2,500 have been expended here in explorations and developments. The district lies in the extreme southwestern part of the county. Several veins have been located and opened, the picked ore from which is worth about $125 per ton in silver, and carries from 20 to 30 per cent. of copper.

Near Gila City the Alva mine was discovered and located about June. The ore found here is an argentiferous copper ore; the silver value of shipping-ore being reported as above $100 per ton. The placer-mines at Gila City and La Paz have been worked irregularly, as in former years, by Indians and Mexicans. The process of "dry washing" has been followed altogether, and as most of the gold has been taken out in small lots, and, as remarked above, by Indians and Mexicans, it is very difficult to arrive at the yield of the placers. Mr. F. H. Goodwin, the sheriff and assessor of Yuma County, estimates, however, judging from the amounts bought by the merchants in Arizona City, that $10,000 will cover the total yield of the two fields here spoken of, for the year 1873.

From Williams's Fork 160 tons of copper-ore have been shipped during the year.

In Pima County, where mining operations have heretofore been impossible, on account of the hostility of the Apaches, considerable work has been done in various parts of the county, since the Indians have been forced to keep the peace. Little or no outside capital has come into the county, but the merchants, professional men, and Government officers at Tucson, have taken hold themselves, and have spent a considerable amount of money and much time in developing lodes of gold, silver, and copper. Early in 1873, C. O. Brown and others made several prospecting trips into the mountains from forty miles west of Tucson, and discovered many abandoned mines carrying silver and copper, especially the latter. Subsequently, Tully, Ochoa & Co., and E. M. Pearce, entered into partnership with Mr. Brown, and some labor was done on the discoveries from time to time, until early in November, when a regular force of men, provided with everything necessary, was put to work on the Mammoth lode. At the end of the year a shaft 5 feet by 6 feet in the clear, was down 60 feet and sinking was still going on. A shaft is sunk along one wall of the vein, which is well defined, and stands entirely in ore, no cross-cutting having been done to find the other wall. The vein contains evidently a large amount of native copper, as do many of the copper veins of that part of Arizona. Assays of specimens sent to San Francisco show a minimum percentage of 41 and a maximum of 89 per cent. of copper; there are about $24 of silver in a ton of ore. The company is now preparing to ship 60 tons to San Francisco. After the Mammoth is opened sufficiently by a shaft to the depth of at least 100 feet, and by levels run from that point, the Young America, another copper lode near by, is to be developed. This lode is 25 feet thick at the surface and the ore is very rich in copper.

About seventy-five miles southeast of Tucson, in Patagonia Mountains, Messrs. E. N. Fish and D. A. Bennett have had several men at work, for the two or three last months of the year, in sinking a 100-foot shaft on a lead and silver vein. This vein is shown in the shaft to be from 2½ to 5 feet wide. The lead-ore occurs very solid, and can be easily sorted; but it is not rich in silver. The owners of this mine intend to erect a smelting-furnace in the rear of the Tucson flouring-mill, and to use power from that establishment. Governor Safford, Dr. J. C. Handy, J. W. Hopkins, R. N. Leatherwood, J. D. Fry, and Thomas Gardner, commenced during 1873 to develop the French mine, situated about sixty miles southeast of Tucson, on the north slope of the Patagonia Mountains. They have expended a considerable sum in working the mines and the erection of small reduction-works. These consist of two small furnaces. Working tests which have been made by Mr. Gardner with the ore from this mine, show that 33 per cent. of lead and 3 pounds of silver per ton can be extracted by smelting. In the shaft, which is sunk to a depth of 25 feet, 22 inches of argentiferous lead are exposed. An official survey has been made of the claim, and a United States patent has been applied for.

Peter Forbach, of Sacaton, and the Starrar Brothers, of Phœnix, discovered, early in 1873, a vein of argentiferous lead-ore in the mountains, about thirty miles south of Sacaton. They have done considerable work in developing the mine, following the vein on the surface and sinking a shaft 30 feet deep. In the latter the vein is exposed 5 feet wide. In the latter part of the year they erected a small furnace at Sacaton, to smelt the ore from their mines; but quite lately they have changed their plans, and are now erecting a furnace within a mile of the mine.

In Pinal district, about twenty-five miles beyond Florence, in Maricopa County, much work has been done by Bichard & Co., Joseph Collingwood, D. W. Reagan, H. B. Summers, E. C. Thompson, and Captain Rogers. The latter has recently shipped 14 tons of ore from the Silver Queen to San Francisco.

Montezuma district is situated about thirty-five miles southwest of Tucson. Here S. Hughes, Tully, Ochoa & Co., H. S. Stevens, A. Lazard, José Fontez, and Miguel Alvarez have expended much money in prospecting and developing. On the Margarita, Montezuma, Esperanza, and Plomosa the largest amount of work has been done. About $4,300 have been expended altogether on these mines. The Margarita and Montezuma have been surveyed, and application for patent has been made. On the former there are three shafts, respectively 25, 20, and 18 feet deep. The Montezuma has two shafts, one 32 and the other 25 feet deep. On the Esperanza three shafts from 16 to 20 feet deep have been sunk, and a tunnel has been started low down on the mountain, with the intention of tapping the vein in depth. On the Plomosa a shaft 30 feet deep is finished, and a contract has been let to sink it 50 feet deeper. On the Isabella the sinking of a shaft 75 feet deep is contracted for. The ore from all these mines is intended to be shipped to San Francisco. Assays made at that place show for Esperanza ore $146.50 in silver per ton, and traces of gold; for Plomosa, $169.64 silver; for Margarita, $153.91, and for Montezuma, $70.68 in silver. Only a few miles south of Montezuma district a very large gold-bearing ledge was relocated in 1873 by citizens of Tucson. The surroundings and the ledge itself show that it must have been very extensively worked years ago, though not one of the present inhabitants of the country knows anything about it. The vein is called the Oro Blanco. During the past year as many as 22 arrastras were at work on ore from this mine. When winter set in all of them had to stop on account of the cold weather in the mountains; but twenty men remained at the mine, developing it and taking out ore. The material so far worked is decomposed ore, and the gold is easily extracted. There is sufficient water throughout the year near the vein to run a 20-stamp mill, and wood is close by in abundance. The vein is claimed by Messrs. Leatherwood, Hopkins, Hewitt, Marsh, and others. The miners at work on the vein at the end of the year worked by permission of the claimants, who do not work the mine themselves at present, but intend to commence mining on a large scale in the spring. So far about 300 feet along the vein have been opened, sufficiently to show that the pay-streak is from 2 to 3 feet thick. The ore so far worked has yielded about $75 per ton. In many parts of the county, beside those mentioned, prospecting work has been going on, and the southern part of Arizona will undoubtedly be favorably heard from during the next year.

For notes on Yavapai County, I am indebted to Mr. H. A. Bigelow, of Prescott. He reports that during the last year but little has been done in the placer-mines of the county, on account of the drought, which has now continued for almost four years; and in the quartz-mines of the county very few new developments have been made during the last year, because little or no outside capital has been invested in the Yavapai mines. There are eight quartz-mills in the county, only one of which was in operation at the end of the year. This is the one belonging to Messrs. Smith & Taylor on the Hassayampa, below Wickenburgh. It will be referred to hereafter. There are two arrastras driven by water-power, one driven by steam-power, and about twenty operated by horse-power, running in the county. As near as ascertained the yield in gold in the county for 1873, has been as follows:

From the Thunderbolt Mill on Lynx Creek	$2,000
From the Del Pasco Mill of 5 stamps, at Bradshaw Mountain, (working on War-Eagle ore)	23,000
From Smith's Mill, on the Hassayampa, (Vulture ore)	55,000
From Rice & Co.'s water-power arrastra on the Aqua Frio, (working ore from the Cornucopia in the Black Hills)	3,000
From the water-power arrastra, on Kirkland Creek, (working Rainbow and Vesuvius ore)	3,100
From the horse-power arrastras on Antelope Creek, (working ore from the Marcus)	7,500
From all other arrastras on Lynx Creek, Hassayampa and other streams	10,000

Seven and a half tons of ore from the Davis mine near Prescott have been shipped to San Francisco and yielded $618.75 or $88.50 per ton. This vein is only opened by a few holes from 5 to 10 feet deep, which show about 8 feet of ore. From the Tiger Mine, thirty miles from Prescott, near Bradshaw Mountain, 35 tons of ore have been shipped to San Francisco, which brought $16,455.14 for the silver contained in it. About 800 tons of ore are on the dump of this mine, which are estimated to be worth $100 per ton in silver. The yield of the placer-mines in Yavapai during 1873 is estimated by Mr. Bigelow to be about $40,000.

In the southeastern corner of Yavapai County, between the head of the Gila River and the San Francisco, the Copper Mountain mining district is located. Mr. E. M. Pearce sends the following notes in regard to this district: The mines are located on the San Francisco River. The country rock is granite. The ores found so far are principally carbonate and red oxide of copper. The principal mines now prospected are the Arizona, Central, Copper Mountain, Montezuma, and Yankee. An excellent water-power, which is effective during the whole year, is situated four miles from the mines. Wood of the best quality for smelting purposes is abundant in the vicinity. The year 1873 has been the first in which work could be carried on without danger from Indians in this district, and considerable development has been made. One hundred tons of copper-ore from developed mines of the district were shipped to Baltimore, with satisfactory paying results. The ores can be sorted for shipping, so as to carry from 30 to 50 per cent. of copper. Placer-gold in small quantities has been found in several of the gulches of this district.

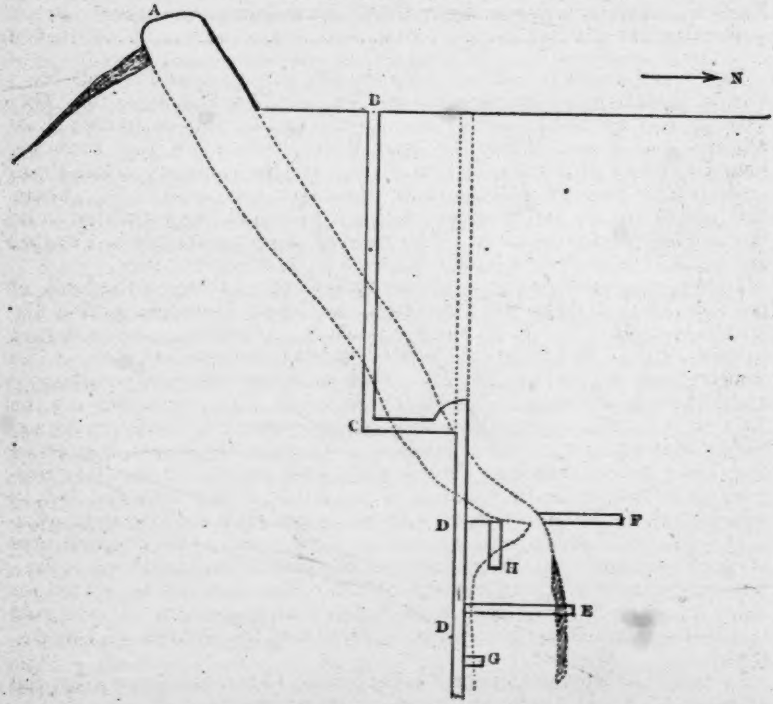
In regard to the mines near Wickenburgh, I have to acknowledge the kindness of Mr. P. Taylor in furnishing information.

The Vulture Company has done nothing on its claim since July, 1872, in consequence of the ore becoming of too low a grade to bear the heavy expense incurred in transporting it fourteen miles for reduction. Of this kind of ore, however, the company has a large amount stored on the surface, in the stopes in the mine, and in the croppings on the surface, which would pay a good margin, provided cheap transportation, or a supply of water for a mill on the ground, could be had. The ore standing in the mine could be cheaply extracted now, as the mine is well opened for that purpose. The company is said to be making some effort to raise capital to either build a narrow-gauge railroad to bring water to the mine, or to purchase road-locomotives. Could either method be adopted, a great deal of gold might be extracted from the vast amount of low-grade ore in sight.

Up to the time that operations stopped on the Vulture, prospecting in the lower shaft was carried on with as much energy as circumstances would permit, and from the work done it is clear that the Vulture is a true fissure-vein of large proportions. The depth attained on the mine is 312 feet below the surface of the mesa, or fully 390 feet below the croppings of the lode. At a depth of 232 feet below the surface of the mesa the fissure was found to change from a dip of 45° north-northeast to an almost vertical position.

SECTION OF THE VULTURE MINE, WICKENBURGH, ARIZ.

Scale, 1 inch to 100 feet.



A, outcrop; B, mouth of main shaft at surface of mesa; C, 182-foot level; DD, interior shaft; E, cross-cut at 282-foot level, showing vein 47 feet thick, with seam of clay on hanging-wall; F, north property drift, at 232 feet; G, cross-cut (unfinished) at 312-foot level; H, small winze.

As soon as it was found that the fissure had assumed this position, a shaft 5 by 10 feet was sunk inside the mine at the north end of the 182-foot level, from the main shaft. This was intended for a permanent hoisting-shaft, which it could be made by raising to the surface, a distance of 174 feet. The shaft was intended to be sunk in the foot-wall of the fissure, which was on the north side of it. Here a thin seam of argillaceous and siliceous matter, about 2 inches thick, was found lying on the foot-wall, which is talcose slate, the same as higher above. It may here be mentioned, that the best body of ore which was taken from the mine was found just above where the fissure changed its dip. It was a continuation of the same body of ore mentioned in my report of 1871. After sinking 50 feet behind the foot-wall, from the 232-foot level, the fissure was cross-cut, and found to be 47 feet in width, and having on the hanging-wall a seam of blue clay some 12 or 15 inches thick. Outside of this was the hanging-wall rock peculiar to the mine above; but the fissure, throughout its width, was found to be filled with a hard black rock full of fine iron pyrites and some galena, and similar in character to the cap or barren filling, which is found in many Colorado lodes. The shaft was then sunk 30 feet farther, and a cross-cut was again made. At this point the fissure stood north from the perpendicular line of the shaft some 6 feet. Only about 6 feet of the cut across the fissure were finished when the work on the mine stopped. The vein-stuff had again changed somewhat, this time for the better; a little more quartz, from which some fine gold was taken, having made its appearance.

As soon as the vertical fissure was struck, water also began to make its appearance, and it increased steadily, though slowly, both in drifting and sinking, but more so in drifting.

This cap, to judge from developments made above, rises gradually toward the east, and dips westerly along the line of the fissure, with the same inclination that way as that which the pay-shoots of ore had above. They were all found to run diagonally west across the dip of the vein.

On portions of the croppings of the Vulture lode, where they have been as yet little changed by the elements, a cap similar to the one below has been found, and fragments of it are also met with in the washes in the valley south of the mine.

The ground that P. W. Smith and Mr. Peter Taylor are now working upon the Vulture lode adjoins the Vulture company's ground on the west, and is an extension of the *bonanza* which that company has worked for six years. It loses none of its proportions or peculiarities toward the west. These gentlemen moved the 10-stamp mill from Wickenburgh last winter to a point due south from that place fourteen miles, and due east from the Vulture ten and a half miles. By so doing they found a better road, and three and a half miles shorter than the old one, thereby effecting a saving of $3 per ton in the transportation of the ore, and reducing the cost of fuel $5 per cord. But they had to bring water to this point from the sink of the Hassayampa, a distance of seven miles. This was done by means of a wooden conduit, 6 by 4 inches in section, and constructed of 1-inch pine lumber, which was buried in the ground to the depth of 2 feet. It has a fall of 30 feet per mile, and supplies the mill with all the water wanted for all purposes. This flume cost upward of $10,000. The mill is built in the most substantial manner. New foundations were put in throughout, and new amalgamating-machinery, new boilers, &c., were added. There is ample engine-power. On an average three cords of wood are burned in twenty-four hours. The stamps weigh 650 pounds each, and drop from 10 to 12 inches sixty-five times per minute. Amalgamation is accomplished in the batteries and on plates on the aprons outside. The apron-plates are electro-plated with silver, and work to perfection. Most of the gold is got from the batteries and front-plates. The pulp is then run from the aprons into a concentrator, (a buddle 8 feet in diameter.) This has a constant discharge, throwing out the light particles. The residue in the bottom is cleaned out twice in twenty-four hours. Then it is put in regular charges into an 8-foot arrastra; a little quicksilver is added, and the arrastra is run for four hours. It is discharged into a large Baux & Guion pan, which runs slowly, acting as a settler. The discharge near the top carries off light particles and slums. From the lower openings the sulphurets are discharged into a tank. These sulphurets assay from $120 to $140 per ton, while the residue that comes from the pan with the amalgam, when it is cleaned out, will assay from $450 to $750 per ton. These concentrates will be shipped for reduction. The quantity of gold saved from the arrastra and pan amounts on the average to $2.50 per ton of ore crushed. Not much remains in the arrastra, as it has a motion of twenty revolutions per minute. The mill was started in full force on the 1st of May, and it has run regularly ever since. The average amount of ore milled was 422 tons per month up to the 1st December; average yield of ore $22 per ton. There are extracted from the mine 25 tons daily. From this amount from 17 to 18 tons are selected to ship to the mill, and the balance is laid aside at the mine; this would mill only from $10 to $14 per ton. All the buildings requisite for the business have been erected, and all necessary improvements have been made, such as boarding-house, men's quarters, assay-office, carpenter and blacksmith shops, office, warehouse, and store, (which is kept by the concern, and supplies the hands with all the necessaries required.) The firm employs from fifty-five to sixty-five hands; miners, mostly Mexicans, mechanics, teamsters, and millmen. About sixty animals are employed hauling ore, wood, and supplies.

From Mojave County I have not had any special report this year; but from what I have been able to gather from different sources, it appears that considerable work has been done in Wallapi district. A new district, southeast of Wallapi has been organized during the year, but no work besides prospecting has been done. The ores of this new district are reported to be even richer in silver than those of Wallapi. The Colorado Steam-Navigation Company reports that 124 tons of silver-ore and 9 tons (213 bars) of base bullion have been shipped from Wallapi during the year. All the ore is of very high grade, averaging probably not less than $500 per ton. The base bullion shipped is reported to be worth about $600 per ton.

According to the data contained in the above notes the yield for 1873 of the different enterprises mentioned is about $350,000. If we take into consideration that a very large part of the placer-gold from Arizona, and also much silver-ore from the southern part of the country, are carried away into Mexico by Indians and Mexicans, it is safe to call the total yield of Arizona Territory, of the precious metals, during 1873, $500,000.

CHAPTER IX.

MONTANA.

The present chapter has been prepared under extraordinary and unexpected difficulties. Mr. William F. Wheeler, of Helena, who has for several years past rendered most efficient service to this Territory by superintending, as my agent, the collection of its mining statistics, devoted to this matter during 1873 an unusual amount of attention and labor, traveling extensively and visiting nearly every mining camp in Montana. In this manner he had accumulated a large quantity of detailed and accurate notes, from which it would have been easy to prepare a review of the condition and progress of the mining industry more complete and valuable than any that has appeared during several years past. The limited means at my disposal do not permit all parts of the country to be treated with equal thoroughness every season, and I had felt particularly desirous, at this stage in the development of Montana, and at a time when, by the sudden collapse of railway enterprises, a check had been given to the progress of the Territory, to publish an adequate representation of its resources and industry. Unfortunately the extensive and destructive conflagration which occurred at Helena on the 9th of January, 1874, while Mr. Wheeler was absent at the East, burned his office and all the papers contained in it, including not only the notes of his report on mines and mining, but also the records and documents belonging to his position as United States marshal for the Territory. The latter loss required of him immediate and exhausting labor, so that he could hardly spare any time to replace, even by scanty and general statements, the material gathered for this report. Nor had I the time or the means to get the work done over again, even if it had been practicable to find a person as well qualified as Mr. Wheeler, and with leisure to undertake it. I am deeply indebted to him for the public spirit with which he has furnished, in the midst of pressing duties and anxieties which he might well have pleaded as good ground for refusal, the notes on which this chapter is based. The statements given are far less detailed and full than they would otherwise have been, but they may be relied on as a trustworthy general account of the subject.

The following estimate of the bullion product for 1873 is submitted by Mr. Wheeler, after careful investigation. He accepts as correct the express statistics compiled by Mr. J. J. Valentine, of San Francisco, the able superintendent of this branch of Wells, Fargo & Co.'s business, but he differs with Mr. Valentine as to the amount carried out of the Territory by other conveyances. This amount Mr. Wheeler estimates at 25 per cent., instead of 20 per cent., of the express shipments, and adds a further sum of $950,000 for gold-dust retained in the hands of miners. Mr. Wheeler's statement is as follows:

	Value in coin.	
GOLD.		
Gold-dust and bullion shipped by express	$3,241,238	
Amount exported by other conveyances	810,309	
Retained in the hands of miners	950,000	
Total gold		$5,001,547
SILVER.		
Silver bullion shipped by express	3,325	
Ores shipped by wagon to Corinne, thence east or west by rail, 347¼ tons; average value, $300	104,175	
Ores shipped to Fort Benton and down the Missouri, 117 tons; average value, $300	35,100	
Base bullion shipped via Fort Benton and the Missouri, 113,755 pounds, or 56½ tons; average value, $600	33,900	
Total silver		176,500
Total bullion production		5,178,047

The foregoing estimate has been submitted to many leading bankers, merchants, dealers in ores, and active mining operators of the Territory, and is indorsed by all of them as within the truth.

A comparison of these figures with those of preceding seasons will show that the product of Montana has decreased from year to year. The causes of this diminution are sufficiently well known. The richest and most easily worked of the placer-deposits have been, in Montana, as in every other auriferous region, first attacked and measurably exhausted. In many cases, the richest deposits have been found in the narrow mountain gulches, where the natural water-courses could be utilized with little or no labor and expense for long ditches. When these were exhausted, ditches became necessary, to bring water to the bars and diggings. This expense, always one of the capital items in placer and hydraulic mining, has been specially onerous in Montana, because of the high rate of wages—a condition maintained in that region after the productiveness of mining had ceased to justify it, by reason of the sparse population and the scarcity of skilled mining labor.

But these economical evils are surely bringing about their own remedy. The number of miners is perhaps nearly or quite as large as it was when the gold-product possessed double its present magnitude; but the yield per hand is notably less. One inevitable result will be a decline in wages; but another is the cheapening of mining by the introduction of large water-supply and of those recent improvements by which extensive areas of low-grade deposits may be profitably exploited. Already capital is investing in large ditches. In Deer Lodge County, particularly, "little giants," under-currents, and all the improved California appliances for rapidly moving auriferous dirt and gravel, and for saving the fine gold, have been introduced. Thousands of acres of ground, formerly considered too poor to pay for placer-mining, are now being taken up and patented; and though not all of this ground will be immediately brought under active exploitation, it will be held only until cheap water and cheap labor shall make its utilization feasible. It is safe to expect, therefore, that even placer and hydraulic mining will experience in Montana, in the same manner, if not the same degree, as in California, a revival and a second period of prosperity.

Gold-quartz mining is slowly making progress in the direction of greater economy and profit. Under the head of Lewis and Clarke County will be found a mention of the successful operations of the National Mining and Exploring Company, which cleared in 1873 over $100,000. Messrs. Blacker & Keating, of Keatingville, near Radersburgh, in Jefferson County, earned about $50,000 net profit during the same period. In the two counties named, and in Madison, Beaverhead, and Deer Lodge Counties, numerous small mills and arrastras are profitably working.

The greatest development in mining for the past two years has been that of the silver-bearing veins. In 1873, about 700 tons of silver-ores were shipped to the railroad at Corinne, and to Fort Benton on the Missouri River, for treatment abroad. Contracts were made during the winter of 1873-'74 by a single banking-house in Helena, to ship 1,000 tons to Europe. It is estimated that nearly 3,000 tons will be shipped abroad during 1874. This ore must average about $300 per ton in value. It has to be hauled in all cases from two hundred and fifty to four hundred and fifty miles by wagon before it can reach railroad or river transportation. The shipment of so much high-grade ore is proof positive of the truth of the statement made to me from various quarters, that thousands of tons of lower grades are mined and kept on hand to await either cheaper transportation or domestic facilities for treatment. Rich ores are only obtained in quantity by sorting over large amounts of vein-stuff; and the higher the tenor of the ores which a district can afford to ship, the larger is the quantity of the ore which it is obliged to mine and to keep on the dump.

The establishment of railroad communication, whether by the extension of the branch road northward from Corrinne or by the extension of the Northern Pacific westward, will undoubtedly develop a large business in the shipment of ores, at first out of the Territory, and subsequently for shorter distances within its limits. The latter business has proved highly profitable to the roads and branches south of Salt Lake City, in Utah.

The treatment at home of the silver-ores of Montana will probably have to follow four different lines, namely: the Washoe amalgamation, without roasting, and with or without chemicals in the pans; the Reese River process, so called, of amalgamation after chloridizing roasting; the smelting processes based on lead, and the smelting processes based on copper. These subjects have been extensively treated in former reports, and considerable space is given to some of them in the metallurgical chapters of the present volume. In this place I shall merely repeat the opinion which I have expressed before, that in Montana, as in some other parts of the West, the smelting processes based on copper will be found in the long run more suitable and profitable than those which have hitherto been employed. I trust to be able next year to offer some practical suggestions in this direction.

The resources of Montana in iron and coal are very abundant and widely distributed, but the present scanty population furnishes no market for the iron manufacture. The coal from the vein at Muller's Pass, fifteen miles from Helena, is extensively used by blacksmiths. It is said to make good coke, but of this I have received no conclusive evidence. In the foundery at Helena it is used successfully in connection with charcoal. The outcrops of coal in the Territory are very numerous, but they have not yet been so carefully studied as to furnish definite evidence as to the quality of the different beds.

This Territory has not been fruitful of inventions and improvements in mining. Its isolated and remote position has caused it rather to lag behind other mining regions of the country, even in the adoption of improvements already known. A single invention is reported to me this year, which has not, however, been put into practice. It is an improved stamp-mill, designed by Mr. G. S. Olin, of Deer Lodge. The novelty consists in having three sets of stamps, placed one in front of the other, and all operated from one driving-shaft by means of belts and pulleys. The mortar-beds constitute a series of inclined terraces, the rear battery standing highest; and the pulp passing through the screens of one battery is discharged immediately into the one next in front, to be crushed still finer. The pulleys and cams are so adjusted that the speed is increased and the drop decreased from the first to the last stamp. Moreover, the first or rear stamp is the heaviest, and has the coarsest screen. This design appears to be intended to secure a uniform fine crushing by exposing the quartz to three successive operations, beginning with slow, heavy blows and terminating with light and rapid ones. Nothing is said about amalgamation, but it will at once occur to practical mill men that both gold and silver ores may be, by this prolonged hammering, exposed to great loss, by the unnecessary formation of large amounts of slimes, which subsequently float off in the battery-water, and are extremely difficult to save. Another objection is the discharge of all the material from one battery into the next, which involves the re-working of much that is fine enough already, contrary to the established principle that pulp of the desired fineness should be let out of the crushing apparatus as quickly as possible. Finally, the increased cost of a triple row of stamps is a serious objection; and it may well be questioned whether there is any such deficiency in the effectiveness of the present stamp-mill as requires so expensive a remedy. It seems to me that the most important points to be improved, if improved they can be, relate to the discharge and to the saving of the gold and amalgam; and in these particulars I see no special advantage to be expected from the combination proposed by Mr. Olin.

The following is a list of mining claims in Montana, plats of which have been made, and copies transmitted to the General Land-Office during 1873:

QUARTZ.

Number.	Name of mine.	County.	Character.	Length of lode.
				Feet.
1	Park Lode, Discovery	Edgerton	Gold	20
2	Union No. 2	do	do	70
3	McIntyre	do	do	13
4	Union No. 2	do	do	16
5	Park Lode	do	do	12
6	Douglas Lode and mill site	do	do	3,00 10 acres
7	Ten-Mile Mining Company, Roderick Dhu Lode	do	do	3,00
8	Ten-Mile Mining Company, Ivanhoe Lode	do	do	3,00
9	A. Brown Chapman	do	Mill	10 acre
10	Union No. 2	do	Gold	30
11	Dexter Lode	Meagher	do	2,20
12	St. John	do	do	2,20
13	Lee Mountain	Edgerton	do	3,00
14	Mountaineer Lode	do	do	50
15	Palmer Lode	do	do	2,00
16	Southern	do	do	1,4
17	Poor Man's Joy Lode	Deer Lodge	do	1,8
18	Rumly and Bugher	do	do	3,0
19	Granite Mountain Lode	Lewis and Clarke	do	0
20	Potash Lode	Deer Lodge	do	2,6
21	Walmissia	Lewis and Clarke	do	3,0
22	Only Chance Lode	Deer Lodge	do	1,2
23	Parkinson Lode	Lewis and Clarke	do	3,0
24	Atlantic Cable Lode	Deer Lodge	do	1,
25	Mountain Chief	do	do	
26	W. L. Thomas Lode	do	do	
27	Noyan	Lewis and Clarke	do	
28	Union No. 2	do	do	
29	Minnesota Lode	Jefferson	do	
30	Western Star Lode	Meagher	do	
31	Union Lode No. 2	Lewis and Clarke	do	
32	Spring Hill Lode	do	do	
33	Union No. 2 Lode	do	do	
34	Green Campbell Lode	Madison	do	
35	Owyhee Lode	Lewis and Clarke	do	
36	Try Lode	do	do	
43	Diamond Lode	do	do	
47	Keating Lode	Jefferson	do	
62	Compromise Lode	Lewis and Clarke	do	
64	Doctor Howe Lode	do	do	
67	Ferdinand Lode	do	do	
69	Wescotte Lode	do	do	
71	Pruitt et al	do	do	
75	Edward D. Young et al, Montana Silver Mining Company	Jefferson	Silver	
78	Rumley Lode	do	do	
80	Mammoth Lode	do	do	
81	Argentum Lode	do	do	
84	Leviathan Lode	do	do	
85	Ohio Lode	do	do	
86	Hidden Treasure Lode	do	do	
91	North Pacific Lode	do	do	
94	Ohio Lode	Meagher	do	
97	Legal Tender Lode	Jefferson	do	
98	First National Lode	do	do	

QUARTZ—Continued.

Number.	Name of mine.	County.	Character.	Length of lode.
				Feet.
99	Second National Lode	Jefferson	Silver	1,500
101	Peerless Lode	Lewis and Clarke	do	600
102	Brownelle Lode	Beaver Head	do	1,600
104	Excelsior Lode	Lewis and Clarke	Gold	2,200
111	R. S. Hale et al	do	do	780
122	Sam Gaty Lode	do	do	1,800
128	Gem Lode	Deer Lodge	do	2,200
129	D. H. Gilmour	Lewis and Clarke	do	2,200
139	Gem Lode	Deer Lodge	do	1,500
140	Allie Brown Lode	do	do	1,500
142	Little Emma Lode	do	do	1,300
143	Cliff Extension No. 2	do	do	1,200
165	Red Bluff Lode	Madison	do	900
175	Silver-Light Lode	Beaver Head	do	1,100
176	Tuscarora Lode	do	do	400
177	Stapleton Lode	do	do	400
182	Lone-Tree Lode	Meagher	do	1,500
195	R. D. Leggett et al., lode, claim and mill-site	Deer Lodge	do	8.39 acres.
196	do	do	do	8.41 acres.
200	Loeber Lode	Jefferson	do	2,200
201	Moltke Lode	do	do	2,200
203	Mountain Chief Lode	Deer Lodge	do	1,500
204	Original Lode	do	do	900
215	Australian Lode	Jefferson	do	1,100
217	Independence Lode	Deer Lodge	do	2,200
219	Daniel Stanton Lode	Lewis and Clarke	do	2,200
220	Micawber Lode	do	do	1,100
221	Gwynn Lode	do	do	900
247	John Murphy, McClellan Gulch Lode	Deer Lodge	do	1,500
248	Gambetta Lode	do	do	2,200
252	Eureka Lode	do	do	1,500
255	Gem Lode	Lewis and Clarke	do	1,500
256	San José Lode	do	do	1,500
257	A. G. Clarke Lode	do	do	1,500
261	G. W. Tibbett's Lode	Deer Lodge	do	2,200
264	North Pacific Lode	Lewis and Clarke	do	1,500
265	South Pacific Lode	do	do	1,500
267	Good Friday Lode	Jefferson	do	1,500
272	Colusa Lode	Deer Lodge	do	2,200
277	Durant Lode	Meagher	do	2,200
284	Mountain Chief Lode	Deer Lodge	do	500
300	Cleve Lode	Beaver Head	do	1,500
301	Avon Lode	do	do	1,500
307	Springfield Lode	do	do	1,188
308	Excelsior Lode	do	do	1,500
309	French Lode	do	do	1,500
310	Wadam's Lode	do	do	1,178
312	Peerless Jennie No. 1, west	Lewis and Clarke	do	1,500
	Peerless Jennie No. 1, east	do	do	1,500
	Little Jennie No. 1, east	do	do	1,500

PLACER-MINES.

No.	Name of owners or company.	County.	Area.
			Acres.
37	Henry Thompson	Lewis and Clarke	35.50
38	Bernard Collins	do	27.74
39	Jesse F. Taylor et al	do	10.60
40	W. W. Carr et al	do	80
41	J. F. Taylor et al	do	20.19
42	J. G. Smith	do	40
44	A. M. Woolfolk	do	160
45	John E. McDonald	do	40
46	J. W. Hyde et al	do	78.50
48	J. P. Barnes et al	Jefferson	100.60
49	J. C. Ricker	Lewis and Clarke	8.21
50	W. W. Morris et al	Madison	20
51	P. V. Jackson	do	158.84
52	Montana Fluming and Mining Company	do	100
53	D. Butterfield	Meagher	50
54	R. S. Kelly et al	Deer Lodge	150.95
55	H. N. Blake et al	Madison	70
56	J. Harsel et al	do	80

PLACER-MINES—Continued.

No.	Name of owners or company.	County.	Area.
			Acres.
57	S. D. McComb et al	Lewis and Clarke	14.50
58	J. F. Wilson	do	56.27
59	H. Gassent	Jefferson	100
60	E. H. Irvine et al	Deer Lodge	40.64
61	A. C. Jones et al	Lewis and Clarke	160
63	W. A. Chessman et al	do	130
65	M. Gales et al	Jefferson	120
66	J. S. Atchison et al	Lewis and Clarke	40
68	D. Hagadorn et al	do	160
70	McDermott et al	Jefferson	149.60
72	R. Kennedy et al	Lewis and Clarke	143.31
73	W. K. Winchel et al	Deer Lodge	160
74	R. Lawrence	Lewis and Clarke	160
75	S. Neel et al	do	160
77	J. C. Richardson	Deer Lodge	50
79	Thomas Stuart et al	do	40
82	John Lloyd et al	Meagher	74.07
83	Richard Hoback et al	Lewis and Clarke	80
87	W. B. Wright et al	Jefferson	160
88	J. H. McDermott et al	do	160
89	W. A. Chessman et al	Lewis and Clarke	160
[illegible]	W. H. Stymeet	do	60
92	J. S. Benson et al	Meagher	160
93	J. Buckingham et al	do	12.55
95	A. McGregor	do	9.63
96	J. E. Hall	do	62.73
100	H. Pflaumer et al	Lewis and Clarke	40
103	F. S. Getchell	Beaver Head	3.98
105	W. B. Dance et al	Jefferson	20.50
106	R. Anderson et al	do	82.42
107	I. B. Cutter	do	12.12
108	C. S. Ellis	Madison	21.95
109	W. T. Dunning et al	Jefferson	32.5
110	A. M. Holter & Bro	Lewis and Clarke	36.42
112	J. O. Nash et al	do	137.40
113	E. W. Moore et al	Deer Lodge	40
114	E. Miller et al	do	40.90
115	D. Driscoll	do	7.44
116	T. Ford	do	15.98
117	T. Ford et al	Deer Lodge	25.35
118	L. Derrich et al	Lewis and Clarke	44.76
119	J. W. Hartwell et al	Jefferson	63.78
120	J. Dean	Lewis and Clarke	58.02
121	G. A. Khem	Jefferson	35.56
123	J. Fagan et al	Lewis and Clarke	120
124	J. Buckingham et al	Meagher	19.85
125	A. Martin et al	Jefferson	36.63
126	D. P. Newcomer et al	Deer Lodge	77.98
127	J. B. Wilson et al	do	160
130	F. Kennett et al	Lewis and Clarke	147.24
131	S. T. Hauser et al	do	156.96
132	do	do	50
133	W. T. Ballard	Deer Lodge	21.10
134	J. Rehery	Lewis and Clarke	67.93
135	S. Loeber et al	Jefferson	156.52
136	J. O'Rourke et al	Deer Lodge	60
137	do	do	25.60
138	G. McDonald et al	Meagher	42.40
141	S. T. Hauser et al	Jefferson	113.81
144	S. Bullock et al	Lewis and Clarke	3.25
145	A. Gerhauser et al	do	16.26
146	T. A. Ray et al	do	12.13
147a	R. Laurence et al	do	90.11
148	W. H. Armes et al	Meagher	71.40
149	J. O'Rourke et al	Deer Lodge	116.94
150	J. R. Quigley et al	do	13.75
151	do	do	23.85
152	Malcom Morrow	Lewis and Clarke	20
153	W. J. Parel et al	Deer Lodge	25.07
154	J. Olsen et al	do	21.24
155	E. H. Irvine et al	do	30
156	D. L. Isbell et al	do	29.22
257	A. H. Watson et al	Meagher	100
158	do	do	80
159	D. P. Rankin	do	6.77
160	T. A. Blain et al	do	38.82
161	A. McGregor et al	do	160
162	do	do	160
163	T. C. Bailey et al	do	106.92
164	M. Ryan et al	do	159.45

PLACER-MINES—Continued.

No.	Name of owners or company.	County.	Area.
			Acres.
166	W. F. Wheeler et al	Meagher	159.22
167	M. Ryan et al	do	42.31
168	do	do	160
169	do	do	160
170	T. Marnell et al	do	75.35
171	do	do	43.25
172	W. Kohlwes	Lewis and Clarke	50
173	D. C. Corbin et al	do	160
174	J. W. Stoner et al	Deer Lodge	11
178	George Wilkinson et al	Jefferson	90
179	Calumet lode, 2,200 feet	Jefferson, including placer	39.39
179	C. W. Cannon lode, 1,500 feet		
179	Queen of the Mountain lode, 2,200 feet		
180	A. M. Holter	Lewis and Clarke	82.62
181	M. Ryan et al	Meagher	160
183	G. Berghofer et al	Lewis and Clarke	143.16
184	J. A. Talbot et al	Deer Lodge	100
185	E. McCrea	Lewis and Clarke	36.02
186	J. Hope et al	do	59.74
187	J. H. Pooley	do	43.80
188	D. A. Linebarger et al	Jefferson	30
189	C. A. Hampton et al	Meagher	7.35
190	T. A. Clark	Madison	20
191	P. Kiely	Deer Lodge	9.22
192	N. J. Dovenspeck	do	5.22
193	H. Bratton et al	do	25.91
194	S. S. Richards	Jefferson	50
197	G. Perry et al	Deer Lodge	130
198	T. C. Brady et al	do	26.95
199	W. F. Mellen et al	do	120
202	John H. Rogers et al	do	70
205	David McKean et al	Jefferson	90
206	Charles Pryse et al	Deer Lodge	31.94
207	T. E. Pounds et al	do	80
208	R. Johnson et al	do	40
209	F. Taylor et al	Lewis and Clarke	118.56
211	I. I. Lewis et al	Jefferson	4.97
212	do	do	4.90
213	J. H. Rogers	Deer Lodge	48.29
214	W. T. Sweet	Jefferson	60
216	B. F. Johnson et al	Meagher	90
218	D. Callaghan et al	Jefferson	80
222	M. H. Marshall	Lewis and Clarke	139.66
223	T. E. Pounds et al	Deer Lodge	67.29
224	B. F. Johnson et al	Meagher	160
225	M. Gales et al	Jefferson	66.86
226	A. O'Connell et al	do	116.75
227	F. Schaal	Meagher	39.26
228	F. R. Bill et al	Deer Lodge	139.72
229	Henry Allen	do	4.18
230	G. W. Monroe et al	Madison	154.75
231	N. H. Webster et al	Jefferson	6.81
232	T. A. Cummings et al	Deer Lodge	160
233	A. G. McKnight et al	Jefferson	13.91
234	M. N. Baker et al	Deer Lodge	80
235	T. Buggy	do	10.58
236	G. Reining et al	do	76.73
237	J. Murphy et al	do	5.66
238	A. McGregor et al	Meagher	143.44
239	H. Bratton et al	Deer Lodge	20.99
240	J. Meeks et al	Meagher	78.75
241	M. M. Holter et al	Jefferson	93.23
242	A. W. Barnard et al	Deer Lodge	34.75
243	J. H. Thomas et al	Meagher	160
244	do	do	159.75
245	F. Mayer et al	Deer Lodge	50.43
246	W. A. Clark et al	do	160
249	W. Collins et al	do	10.80
250	G. D. C. Hibbs et al	do	56.77
251	C. D. Hard et al	do	160
253	A. A. Brown et al	do	10.96
254	R. T. Kennon et al	do	160
258	G. S. Harrison et al	Jefferson	29.50
259	J. G. Steele et al	Deer Lodge	160
260	G. W. Irvine et al	do	120.35
262	J. Noyes et al	do	27.30
263	R. S. Kelly et al	do	150.10
266	F. B. Miller et al	do	71.46
268	W. Sandford et al	Lewis and Clarke	39.54
269	S. T. Hauser et al	do	113.05
270	do	do	118.57

PLACER-MINES—Continued.

No.	Name of owners or company.	County.	Area.
			Acres.
271	A. Monahan et al	Deer Lodge	70
273	D. Freyler et al	Jefferson	56.76
274	S. S. Harvey et al	do	120
275	T. Scanlan et al	Meagher	160
276	do	do	160
278	J. Armitage et al	Lewis and Clarke	63.95
279	W. W. Prouse et al	Deer Lodge	112.74
280	G. Hedges et al	Meagher	36.16
281	W. W. Higgins et al	Deer Lodge	160
282	D. Freyler et al	Jefferson	55.36
283	T. Scanlan et al	Meagher	160
285	J. A. Rich et al	Deer Lodge	156.36
286	J. S. Kelly et al	Meagher	115.02
287	J. A. Campbell et al	do	3.31
288	W. F. Sanders et al	do	156.78
289	M. Nunan et al	Jefferson	156.25
290	J. McDermott et al	do	53.15
291	do	do	132.05
292	J. A. Talbot et al	Deer Lodge	70
293	C. L. Harrington et al	Meagher	34.16
294	John T. Bristol	do	34.80
295	L. C. Miller et al	Lewis and Clarke	100
296	G. W. Cleveland	do	100
297	S. A. Addis et al	Jefferson	40
298	J. E. Sites et al	do	36.60
299	G. W. Reed et al	Lewis and Clarke	35.45
302	S. T. Hauser et al	Jefferson	160
303	G. J. Jackson et al	Deer Lodge	28.42
304	C. B. Vaughan	Lewis and Clarke	39.37
305	R. Lawrence	Jefferson	160
306	do	do	110
311	J. J. King et al	Meagher	20.54
313	Dennis Dana	Deer Lodge	43.91
314	D. W. Culberson et al	Meagher	137.15
315	W. S. Tutt et al	Jefferson	47.07
316	O. Kimmerly et al	Deer Lodge	63.51
317	H. M. Hubbard et al	do	55.16
318	G. E. T. McKiernan et al	do	160
319	Nicholas Gremish	do	23.34
320	A. A. Whittier	do	33.60
321	Benjamin F. Tift	Meagher	7.96
322	Charles G. Birdseye	Deer Lodge	20.20

DEER LODGE COUNTY.

This county has for some years past yielded more from placer-mining than any other in the Terrrtory. The mines are more extensive and better worked, with more of the improved appliances than in the other counties. Placer-mining is the principal industry of the county.

A very fair description of the silver and copper leads of this county was published in the last report. Developments have been carried on to some extent during 1873, but owing to the expense of shipping ores from three hundred to four hundred miles to the railroad, only small amounts have been shipped. It is anticipated that large amounts of ore will be shipped during the year 1874, as the returns from the ores shipped in 1873 prove that the enterprise may be carried on with profit.

Capital and skill would find remunerative investment in erecting mills and machinery to work the valuable ores in this county. Movements are on foot to this end, especially at Phillipsburgh.

Mr. C. W. Frost writes from Phillipsburgh that some 35 tons of silver-ore were worked by hand and crude machinery, which yielded $275 per ton.

The Speckled Trout mine has a shaft 114 feet in depth, showing a vein from 9 to 11 feet wide, and assaying about $200 per ton. During the next year an eastern company will erect proper machinery to work the ores of this and adjacent mines.

The Poor Man's Joy is a remarkable lode in this district. The vein is 4 to 6 feet wide, and works from $60 to $1,100 per ton. Specimens have assayed, yielding as high as $15,000 per ton.

The Comanche, Potosi, Salmon, and other leads have been developed to a considerable extent; and Mr. Frost estimates that there are 50,000 tons of ore in camp that would average in working at least $20 per ton. This grade can be profitably worked, with suitable skill, if the Washoe process is applicable, not by roasting or smelting.

Preparations for larger developments of the rich veins at Butte City, Silver Bow, and Moose Creek, described in last year's report, are making for the year 1874.

Moose Creek district.—The old Atlantic Cable gold-mine, at Cable City, has been worked very imperfectly during the past year, but has developed very richly and profitably to Mr. Cameron, who is working it. Litigation for some years past has prevented the necessary work on this mine to show its full worth. The suits in court are in a fair way of settlement, and, when all disputes are ended, no one doubts but the Atlantic Cable lead will prove itself, as it was believed to be when first worked, extraordinarily extensive and valuable. Mr. Cameron writes me that in December, 1873, he made a small run of 180 tons of quartz, which paid $20,100, or $111.67 per ton. Two tons of selected quartz from the same lot yielded $9,000. In the spring of 1874 he was extracting ore which would mill about $50 per ton.

LEWIS AND CLARKE COUNTY.

For reasons already stated, I have not attempted to give any description of placer-mining in Montana during year 1873. The larger part of the gold comes from the placer-mines, which show a uniform profitable yield, so far as they have been worked at all; but several mills are running on gold-quartz very successfully.

Samuel J. Jones, esq., superintendent of the National Mining and Exploring Company—the mines of which, situate four miles south of Helena, at Unionville, have been mentioned in former reports—makes the following report of operations for 1873: The mill was closed from the 1st of January to the 31st of March. From the latter day to Christmas eve it crushed 5,208 tons of ore, yielding $154,048.30 in gold, which sold $173,852.87 currency. Expenditure, about $8,000 per month. This, as well as the previous year's yield, was from ore out of the Owyhee claim, on the Union lode. The past three weeks have been spent in a thorough overhauling and refitting of the mill, increasing its crushing capacity 25 per cent. The dumps contain over 1,000 tons of ore, and the mine is in first-class working order.

The company has purchased the Ricker claim, on Union lode, (200 feet,) for $35,000. The capacity of the mill has been increased by refitting and additions from 24½ tons to 32 tons per twenty-four hours. The mill uses 20 stamps, weighing about 625 pounds each. The prospects for next year are flattering. The results for 1874 promise to be much better than for 1873. In this district several other mills are working very profitably, and one or two are running entirely on custom-work. The costs of working gold-ores are diminishing every year, and many veins which have not heretofore paid will in the future be worked. Lewis and Clarke County has a large number of leads of this description which may, in the near future, become profitable to their owners.

Ten-Mile district.—This district is situated at the headwaters of Ten-Mile Creek. The lodes of mineral are situated in the vicinity of that stream and its tributaries, Banner, Ruby, and Minnehaha Creeks. On the main stream lodes are found from the main Rocky Mountain divide to the mouth of the cañon and below, a distance of some fifteen miles in all.

The main belt is probably the same as the Boulder district belt, which lies farther east. It also extends westward over the Rocky Mountain divide and appears on the Blackfoot. These lodes have not been extensively explored. The best mines and the most extensively worked are two miles from the head of the creek on Red Mountain, which is on the east side of the creek and twenty miles from Helena, by a well-graded road all the way. The mountain is about 9,000 feet high and 3,000 feet above the level of the creek, affording a fine chance for tunneling, since it rises with an angle of about 37° and faces westerly in such a direction that on most of the lodes drift-adits can be run. The top of the mountain is porphyry; the country rock is common granite and syenite; large veins of hornblende are occasionally found.

The direction of the lodes is about 2½° north of true east. There are three or four lodes which run 22½° north of east, among which are the American Flag and Lee Mountain.

One and a half miles above Red Mountain, four companies are engaged in placer-mining, and get fair returns. Gold is found all along the cañon; but, the bed-rock being deep, not much has yet been done in the way of thorough work.

Coal is found on the main divide at the head of cañon. In one vein coking coal is found, which is used at Helena. These veins, as yet, have been opened but slightly, wood being plentiful and cheap.

The principal mine at present is the old Emma, now known as the North and South Pacific, the property of J. H. Russell, of Helena. At the bottom of a 30-foot shaft there is a 4-foot vein of rich ore, comprising sulphuret of lead and silver, and brittle and antimonial silver. It assays from $230 to $2,000 per ton. Some 20 tons have been smelted at the Helena works and as much more shipped to San Francisco. There are now two shafts in the mine, one 30 feet, another 50 feet deep. There is also a tunnel some 180 feet long, which will tap the extension of the 30-foot shaft when it shall have advanced about 30 feet farther.

The Silver Glance mine, belonging to the Gilt-Edge Mining Company, of Helena, is south of the Emma, and is the most extensively worked mine in the district. Some of the ore has been shipped East; but most of it has been worked at the company's mill at the foot of the mountain. This is an improved Chilian mill, and of course small in capacity; about 100 tons have been crushed and worked, and 12 tons shipped. The ore is antimonial and brittle silver, with sulphurets and also native silver. The mine is worked by a tunnel which is now 300 feet long. A shaft is being raised and another sunk from the tunnel-level. Drifts are run off from these to facilitate stoping.

The Micawber lode, the property of Tatham & Bros. of New York City, is a large and strongly defined vein from 4½ to 5 feet wide. It has been stripped and shown for 150 feet in length. The shaft is down 40 feet, and 80 tons of milling-ore are on the dump, said to average $75 in gold and silver. There are also 5 tons of galena-ore of low grade and 5 tons of rich antimonial silver-ore valued at $500 per ton.

The Eureka lode, the property of the Ten-Mile Mining Company, of Helena, is 3 to 4 feet thick, carries galena-ore. There are 80 tons of ore on the dump and 20 tons at Helena. The yield is from $50 to $300. The mine has a tunnel 100 feet long and a shaft 40 feet deep.

The American Flag lode is the property of William Rowlan & Co.

A test of a few tons of this ore shows it free from impurities and easy to work in the mill. It contains some native silver and averages from $75 to $300 per ton in two grades. The vein is 4 feet wide and shows plenty of ore in sight.

The Lee Mountain and Elizabeth Meagher are two promising lodes. The former is 15 feet wide between walls. Both carry galena, but are not developed.

The Klontarf, Wolftone, and others are the property of John Caplicé and Murphy, Neel & Co., of Helena. Value unknown.

The Teale Lake and Gilmore lodes belong to Gilmore, Walker & Blaine. Both are considered good veins and have been developed fairly. The Teal Lake has two tunnels run in on the vein, one 80 feet, the other 30. There are 40 tons of galena-ore on the dump, averaging $75. One of the walls of this mine is porphyry.

The Try Again is the property of Hoyt Brothers. The shaft is 110 feet deep, showing a vein 18 inches wide carrying brittle silver-ore. The assay value is $100 to $1,200 per ton.

The Red Mountain, Little Sampson, Michigamme, Knight of Gwynne, Daniel Stanton, and many other lodes are more or less developed, and show galena and other ores carrying silver.

All the above-mentioned mines are on Red Mountain proper. Near the main divide a number of veins with galena and carbonate of lead are worked through a single large tunnel by Travis Brothers.

On a hill back from the head of Ruby Gulch is the Little Jenny lode, the property of C. B. Vaughan. This was located in 1871. Two tunnels have been run in the mine about 400 feet and 300 feet long respectively. The vein is about 18 inches wide, and the ore is said to yield from $200 to $3,000 per ton. This doubtless refers to the material sorted for shipment, of which, up to the present time, over 100 tons have been sent away for treatment by smelting.

Providence Hill and *Bismarck Hill* are on the east side of Red Mountain, about one-quarter of a mile apart, and eighteen miles from Helena. More than a hundred locations were made last year within two miles of this point. A few only of the leading claims will be enumerated:

The Good Friday lode, located July 24, 1873, belongs to Horst, Dorr, and Arnold. The claim covers 1,500 feet. The vein is from 3 to 6 feet wide, carrying galena and silver ore. A tunnel on the vein 100 feet in length, a shaft 42 feet deep and 11 feet square, and stopes from which, together with these openings, about 200 tons of $250 ore have been extracted, constitute the present workings. The cost of the improvements is valued at $4,000, and a patent has been applied for.

The Crown Point lode, located September, 1873, belongs to the same parties. The vein is of similar mineralogical character, and has been exposed to a width of 3 to 4 feet by a pit 12 feet deep. The ore assays $100 to $150 per ton.

The Great Western lode, also owned by Horst & Co., was located in 1872. An open cut has been made on the vein, 200 feet in length, and about 20 tons of galena and silver ore have been extracted, said to be worth $200 per ton.

The S. Lober lode, located in 1872 and owned by Horst & Co., has been exposed by an open cut for 100 feet, and 10 tons of ore, said to yield $200 per ton, have been extracted.

The Nellie Grant, located in 1873, is owned by A. Agno. It has a tunnel about 40 feet long, showing silver and galena ores. About 30 tons already extracted are estimated to be worth $175 per ton.

The Star of the West, located July 26, 1874, belongs to Heath and

Rogers. It has a tunnel on the vein about 40 feet long, and a prospect shaft about 12 feet deep. The galena and silver ore from the vein is reported to be worth $100 to $150 per ton.

The Star of the East, located September, 1873, and belonging to Heath and De Rue, carries galena and silver ore valued at $100 per ton.

The Blondino, located August, 1873, by the same parties, is a vein 3 to 4 feet wide, carrying milling-ore said to yield $100 per ton.

The Minnie, located July, 1873, by Horst & Co., has a pit 12 feet deep, and has furnished galena and silver ore valued at $200 per ton.

The foregoing lodes are all on Providence Hill. On Bismarck Hill the following may be named:

The Lober, located November 15, 1871, and owned by Horst and Lober, is opened by a shaft and a tunnel on the vein, which are not yet connected with each other. The shaft is 80 feet deep, and has furnished about 100 tons of galena and silver ore, worth $225 per ton. It contains a vein 4 to 5 feet wide. The tunnel has been started about 475 feet down the hill from the shaft, and run in upon the vein 44 feet. In this tunnel the vein appears 12 feet wide.

The Horst, located November 27, 1871, and owned by the same parties, is opened by a cut on the vein 40 feet long. It is said to yield milling-ore worth $200 per ton.

The Parchen, located October 2, 1871, and owned by the same parties, is opened by a tunnel 30 feet long, and is reported to yield milling-ore worth $175 per ton.

The Bismarck, located October 12, 1871, and owned by the same parties, is opened by a tunnel 50 feet long, the milling-ore from which is valued at $150 per ton.

The Moltke, located October 20, 1871, and owned by the same parties, has a tunnel 60 feet long, and furnishes milling-ore reported to be worth $160 per ton.

The Empire, located September 27, 1872, and owned by Horst & Co., is opened by a tunnel 225 feet long, exposing a 4-foot vein of galena and silver ore, worth, as reported, $250 per ton.

The Adelaide, located June, 1873, and now owned by the same parties has a tunnel 20 feet long, and carries galena and silver ore valued at $250 per ton.

The Dana (or Danae?) located June, 1873, and owned by Dorr & Co., is opened by a shaft and cut, and is said to furnish $200 ore.

The California, located June, 1873, and owned by Dorr, Horst and Arnold, has a shaft 18 feet deep, and carries, it is said, milling-ore worth $100 per ton.

The Concord, located June, 1873, and owned by the same parties, is reported to carry milling-ore worth $90 per ton.

The figures given for the value of the ores from these Providence Hill and Bismarck Hill mines cannot be adopted, in the absence of more extensive working and actual shipments on a large scale, as conveying an accurate notion of their average yield. Yet that large quantities of ore, ranging from $100 to $250 per ton in value, can be produced with (and to some extent without) hand-sorting, the experience of Reese River, Utah, and other western silver-districts, makes it easy to believe. Some of the mines above enumerated have indeed furnished considerable amounts of rich ores. The Little Jennie, already mentioned, with the Peerless Jennie No. 1 west, and Peerless Jennie No. 1 east, are the property of Mr. C. B. Vaughan. The average value of the ore taken from these veins is remarkable. Fifty tons averaged 900 ounces of silver per ton, and 200 tons averaged nearly 500 ounces per ton. Mr.

Vaughan has earned by working these mines in the year past, a handsome profit, notwithstanding that at first he had to borrow money, at a high rate of interest, to develop them, grade an expensive road for some miles, to get to the veins, which are high up on the mountains, and pay a high price for every pound "packed" up, and for the labor employed. He expects in the next year to ship 200 tons of ore, the value of which is at least $500 per ton. With adequate capital to enlarge operations, greater profits could be secured in the same period.

MEAGHER COUNTY.

In preparing estimates of the product of this county, Mr. Wheeler relied upon the assistance of Mr. J. E. Hall, of Diamond City, a gentleman well acquainted with the industry and the people of the county. Mr. Hall made diligent inquiry of men from all parts of the county, and from his own knowledge and the information thus obtained made up the following estimate, which he thinks nearly correct:

The gold produced from the placer-mines of Meagher County, during the year ending December 31, 1873, amounted to about $265,000, to be credited to the several parts of the county in the following amounts: Thompson's Gulch and all the other gulches lying east of the Belt range, $60,000; Confederate Gulch and its tributaries and bars, $75,000; White's Gulch and its bars, $30,000; all the lower or north end of the county, including New York, Cane, and Oregon Gulches, and the bar situated on the Missouri River, $100,000.

Concerning the future of the placer-mines, Mr. Hall says that present developments are sufficient to warrant the expectation of the continued productiveness of the ground now worked for many years to come; not in such amounts as in some former years, but to the full capacity of the water that is available for mining purposes. Of the undeveloped placer-mines of the county, he has the most sanguine hopes, and he thinks not without foundation. The developments of the last few months on the Jefferson River have demonstrated that the placer-mines of the Territory are not confined to the small streams, but that in the near future we may reasonably hope for extensive discoveries to be made in the larger streams, and of these Mr. Hall considers the Missouri River itself one of the most promising.

Concerning the lode-mining interest of the county there is but little to report. Not much work was done during the year 1873. Some new lodes were opened on Duck Creek, about twelve miles south of Diamond City. These lodes were located in May; and shafts have been sunk on three of the lodes to a depth of from 20 to 40 feet, and a very favorable "prospect" has been obtained from the quartz. The character of the quartz is hard rock, bearing free gold.

Two arrastras were built late in the fall of 1873, for the purpose of working the quartz from these mines, but, owing to the lateness of the season, nothing was accomplished that fall. On the opening of the mining season in the spring of 1874, the arrastras were put in operation, and from two tons of the ore, I am informed by Mr. Thomas Howell, $125 have been cleaned up. More men will be set to work during the summer, and the erection of a mill on Duck Creek will give the needed facilities of reduction to this promising camp.

On Gold Hill, near Diamond City, Messrs. Howard and Emerson continued a shaft down till they struck water at a depth of 80 feet. They have a good crevice and very fair ore, but there being no facilities for working their quartz, they have suspended work until such time as they may be able to have their ore worked. They now have about 100 tons on their dump.

There has been no activity in the copper-mines east of the Belt range on the Musselshell River. Assurances are given, however, that during the approaching summer some of the ore now lying on the dumps at those mines will be shipped to some point where it can be thoroughly tested, and if it prove but one-half as rich as sample assays indicate there will be a basis of extensive and profitable industry. The new road to Carroll will make it possible to remain in that country, to work, and will also furnish the means for shipping the ore to the river.

In other parts of the county nothing new has been developed, nor do I expect much prospecting will be done till after June 10, 1874, when, if the time for doing work to hold possessory title on old claims is not extended, many of the locations made by early prospectors, now non-residents of the Territory, will be relocated, and some of them developed.*

JEFFERSON COUNTY.

In my last report a tolerably definite description of the developed lodes of this county was given. The silver-bearing veins of Jefferson are no doubt better developed than those of any other county in Montana. Of the amount of silver-ores shipped from the Territory heretofore, Jefferson County can be credited with considerably over one-half. In this respect the county still takes the lead, though silver-mining in Lewis and Clarke, Madison, Beaver Head, and Deer Lodge Counties also is now well established, and generally prosperous. During the coming year the amount of ores shipped and worked at home will be quadrupled. Improvements of every kind are being made. New mills, concentrators, and furnaces are in process of erection. But the aggregate capacity of these will be inadequate to the treatment of the ores now on the dumps.

The Legal Tender, Mammoth, Argentum, Rumley, and other lodes heretofore described still maintain their character for stability and richness, and rate at a much higher value than ever before.

GALLATIN COUNTY.

This county has not heretofore taken rank as a mining district, but several late discoveries indicate that fine silver-bearing veins exist within its limits. On Sixteen-mile Creek, one of the most promising silver-veins in the Territory has been found, and sufficient developments have been made to give it a high probable value. The bars along the Yellowstone and the Gallatin Rivers have been proved by prospecting to contain gold deposits, which, when capital can be found to bring a head of water upon them, may be profitably exploited. Coal is found in this county in abundance.

MADISON COUNTY.

Placer-mines.—This county has furnished the richest placer-mines in the Territory, and although the excitement of the early days of Alder Gulch has entirely subsided, the mineral wealth of the county has scarcely begun to be exhausted. But this wealth consists mainly in quartz; and lode property, unlike placer-mines, requires large capital to work it. However, the placer-mines of Madison are by no means worked out, and there are still many gulches giving remunerative employment to a number of miners.

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* This extension will doubtless be made at the present session of Congress. I trust it will be the last. Great as may be the incidental hardship to individuals, the general good imperatively requires that old and new claims alike should be either bought of the Government under patent, or worked, or thrown open to re-location.—R. W. R.

Brown's Gulch is a tributary of Alder, entering below Virginia City. The gulch is seven miles in length, and a considerable portion as yet unworked, that will pay, it is said, from $3 to $10 per day to the hand.

Bivin's Gulch is a tributary of the Stinking-Water, below Alder Gulch. There were ten companies at work in this gulch during the last season, all doing as well, and some better than in the previous year.

California Gulch is a tributary of the Stinking-Water. There is a large amount of unworked ground in this gulch. The ground is spotted and very rich in places. Very large sums of money have been realized in the mines near its mouth. A nugget weighing fourteen ounces was once taken from this gulch.

Granite Gulch is a tributary of Alder, about ten miles in length, and contains a large amount of ground that will pay the miner from $2 to $3 per day. It is at present unworked. A large company could work the whole to advantage.

Harris Gulch, a tributary of Stinking-Water, is considered rich, produces a fine quality of gold, and contains much unworked ground.

Idaho Gulch, a tributary of Stinking-Water, was discovered in 1864; has not been worked much, but will pay miners good wages.

Mill Creek, a tributary of Stinking-Water, contains coarse gold, but is difficult to work, and has not yielded much.

Meade's Gulch, a tributary of the Upper Stinking-Water, yielded a considerable amount of gold last year.

Norwegian Gulch, a tributary of Upper Willow Creek, has yielded well, and still continues to pay small wages. With plenty of water, it might be made to pay better. Considerable ground has been taken up under the mineral-land act. One miner in this gulch took took out over $1,000 last season, and the season is very short. The gold taken out of this gulch since its discovery is estimated at $150,000.

Romhorn Gulch is a tributary of Curant Gulch, about thirteen miles in length. The ground is reported to pay from $3 to $5 per day to the hand.

Rochester Gulch, a tributary of the Jefferson, has yielded considerable gold, and continues to yield small quantities.

Washington Bar has yielded well, and continues to pay fair wages to the miner.

Willow Creek, a tributary of the Jefferson, has paid, and continues to pay well, some portions yielding as high as $10 to the hand per diem.

Wigwam Gulch, a tributary of the Madison, will pay small wages. It was worked some years since and abandoned, as it would not pay in those times when provisions were high. Probably from $2 to $3 per day to the hand could be obtained here.

The yield of the placers of Madison County for 1873 was about $800,000, which must be considered good, considering the diminished number of men at work.

Lodes.—The quartz-mines of the county present no special mark of progress during the year. It must suffice for this report to enumerate the leading districts and lodes.

Brown's Gulch district.—Brown's Gulch is a tributary of Alder, entering the latter below Virginia, on the left-hand side. It contains the following lode-claims, all claimed as silver-lodes: The Black, Barret, Curry, Easton, (ore from this lode has yielded as high as $100 to the ton,) Gould, Louane, Pacific Railroad, (has a tunnel 100 feet long, at the end of which is a crevice 2 feet in width,) Roma, True Silver, and Wright lodes. There has been a large amount of work done in this district, and it promises well, though it is not regularly productive.

Fairweather district.—This district is on Alder Gulch, and includes Virginia City. There are a great many gold-ledges claimed and recorded in this district, but hitherto they have not shown much evidence of their value. The best-known lodes are the Alameda, Sonoma, and U. S. A., containing both gold and silver. Some of the ore from this district has been worked by arrastra and pays fairly.

Granite Creek district.—Granite Creek is a tributary of Alder. The district is about four miles to the north of Virginia City. The principal lodes are the Kremlin and Mapleton, the former gold-bearing, the latter bearing both gold and silver.

Highland district.—Considerable quartz-mining has been done in this district. The principal lodes are the Adamant, Chickamon, Dixie, Meyer & Thompson, Nevins, Nonpareil, and Only Chance. This district lies northwest of Virginia City, and is also known by the name of Red Mountain.

Hot Spring district.—This district is about thirty miles northeast from Virginia City. An immense amount of labor has been performed, and thousands of dollars expended in working the quartz of this locality, but without any very great results as yet. It is generally conceded that the quartz-mining operations in this district were in early days grossly mismanaged. At the present time there are a few mines working, and from all appearances some of them are successful. Among these may be mentioned the Mother Hendricks, Red Bluff, Rising Sun, and Chihuahua. The most prominent claims in this district are the Boaz, Bill Norton, Blue Lead, Chihuahua, Calaveras, Convoy, Galena, Golden Echo, Homeward Bound, Mother Hendricks, North Lode, Old Mortality, Opula, Primrose, Pony, Pine Tree, Purdy, Purdy Extension, Rising Sun, Red Bluff, Sterling, Thad. Stevens, Velocipede, and Woodruff and Beach lodes.

Havana district.—This district is about four miles east of the Madison River, and near the Madison bridge. The mines of this locality are known as the Cherry Creek silver-mines. At the present time this is a very promising mining-district. Some of the lodes are rich and are paying well. Considerable rock has been shipped for smelting. Among the lodes may be mentioned the Clagett, Davis, Enselman, Eberhardt, Joe Brown, Lucy Henry No. 2, Silver Crown, and Silver Shower. The ores of the district carry a great deal of free silver.

Meadow Creek district is included in the Hot Spring district.

Mill Creek district.—A vein called "The Lost Lode" is the most prominent in this district. It is a gold-bearing ledge of great width, and is said to yield from $10 to $20 per ton. The quartz is easily removed. The owners of this ledge have been running a 12-stamp mill, but are now making arrangements for the shipment of a 20-stamp mill. Other lodes in this district are the Antelope, Aurora, Branham, Eclipse, Gemmel, Isabella No. 2, Lebanon, Mountain Queen, May Flower, Ohio, Oroy Plata, Sunrise, and Tippecanoe.

Quartz Hill district.—The principal lodes in this district are the Fry and Martha Compton.

Rochester district.—Among the prominent lodes in the district may be mentioned the Day, Julia Holmes, Parepa, and Watseka. Some of these lodes are being worked with great profit, and the town of Rochester which was abandoned, has now a population of about one hundred. Better methods of working have caused this prosperity.

Many of the above-named lodes were mentioned in last year's report. Some new ones are named in this.

Silver Star district.—This district is on the west side of the Jefferson River, in Madison County, and several small mills are doing profitable work in it. It contains a large number of rich gold-lodes, although most of the veins are narrow. At present rates of expenses they are remunerative, and will be more so as prices are better adjusted. Accounts of this district, particularly of its leading mine, the Green Campbell, will be found in my report rendered March, 1872, and in subsequent volumes.

BEAVER HEAD COUNTY.

Bryant district.—This district is located forty miles due north from Bannack, at the source of Trapper Creek, a tributary of Big Hole or Wisdom River. It was discovered in the summer of 1873. The formation is crystalline magnesian limestone, on which granite bowlders occur in great profusion. The district is shaped like a horseshoe, the opening toward the river. The locations of the various lodes are upon inner and rugged acclivities in steps or benches up to the summit of White Lion Mountain and South Mountain, at an elevation of from 9,000 to 10,000 feet above the level of the sea.

The opinion widely obtains that high altitudes are the most favorable for rich and inexhaustible silver-mines. If such is an invariable rule, this district may be another instance of it.[*]

There is a beautiful park of fine pine timber within this circle, containing numerous springs of pure cold water, which unite to form Trapper Creek. In the center is a low ridge, two miles in length, running from the South Mountain to the opening, on the north side of which is Trapper Creek, containing about 1,000 inches of water. On the south side is a brook called the South Fork, which empties into Trapper Creek, in the low opening of the horseshoe.

There is abundance of good timber for building and fuel, and good water-power, within the park. Below the park and toward the river is also plenty of good timber and water-privileges. The park is about two miles square.

Some of the main lodes are on this ridge, having a strike and dip similar to those on the South Mountain.

The Trapper is one of the chief veins of the district, and every indication shows that it will prove to be an extraordinary mine. The strike of the vein is from east to west; the dip, 40° south. The vein of ore is 3 feet wide at the surface in the discovery-shaft, and 9 feet at a depth of 50 feet. There are several shafts along the lode, sunk to the depth of from 15 to 50 feet. On account of the decomposed nature of the ore and country-rock the vein does not crop above the surface, but it is traceable for the whole length of the claim—1,500 feet. The ore contains galena and argentic sulphides; and numerous assays give from $100 to $15,000 per ton in silver.

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[*] This suggestion I leave in Mr. Wheeler's words. There is no such rule. The popular impression to that effect may be attributed to several circumstances: 1. Mineral-deposits are the incidental products of disturbances and changes in the earth's crust; hence, fissure-veins particularly are likely to occur in mountain-ranges. 2. Mountains offer more exposures and less covering detritus or alluvium than lowlands; hence, the veins they contain are more likely to be discovered. 3. Sometimes the sides of a mountain may consist of sedimentary upheaved strata, not containing-veins, and the central core may be crystalline rock carrying such deposits. In that case only the highest parts of the range would show the veins. But the question of absolute altitude above the sea is not connected with the value of the veins.—R. W. R.

Seven tons of ore were hurriedly shipped to San Francisco last fall, and a return of $500 per ton in coin was received.

This lode was discovered by James Bryant, after whom the district is named. It is now owned by the Trapper Company, in which he is interested.

The same parties discovered and own the Forest Queen and Lady Elgin, continuations of the Trapper lode westward. There are four shafts along the course of these lodes to the depth of 15 feet each, showing the veins of ore 2 feet wide and similar to the Trapper ore, but not so much decomposed. Wire silver is easily panned out of the decomposed quartz on the Trapper. There are over 250 tons of ore on the dump, and 100 tons of high grade ready for shipment.

The Argenta is also a plain continuation of the same vein. It is traceable by the ore and stained rock the whole length of the claim. The vein of ore is two feet wide, and is not so much decomposed as the Trapper ore, and contains less galena. It is good milling-ore, at least on the surface. Hon. G. W. Stapleton is the discoverer and owner of the vein. Owing to the early fall of snow last winter he had not done any mining on it at the close of the year.

The Minnie Gaffney belongs to the Gaffney Company, and lies south of the Trapper vein and parallel to it. There is a shaft 30 feet deep on this vein, which is 2 feet at the surface, and 3 feet at the bottom of the shaft. The vein at the surface is mostly quartz-bearing blocks of galena. At the bottom of the shaft the ore is much improved, and assays from $100 to $200 in silver, per ton. There are 50 tons on the dump. The quartz is hard and flinty, and crops out 600 feet along the strike of the vein.

The Eleo Mer Lou belongs to Dewey & Co., and is traceable the whole length of the claim, (1,500 feet.) The vein is 3 feet wide. The ore is copper glance and rich in silver.

The Keokuk is a distinct continuation of the Eleo Mer Lou. The strike of the vein is easterly and westerly, with a dip of 30° to the south. It is 2 feet wide at the discovery shaft. The vein-matter is mostly decomposed, and according to four assays made, yields from $122 to $290 in silver per ton. An average assay made of the whole gives $200 per ton.

This lode is probably the best defined contact-vein in the district, and is traceable the whole length of the claim, 1,500 feet. It lies between two distinct formations. The foot-wall is dolomite and the hanging-wall trap. The walls inclosing the vein of ore are smooth and polished. The ore contains a small percentage of galena, and is colored yellow, blue, black and green. It is good milling ore, and in character unlike any other in the district.

The owners, Messrs. Stapleton & McCammon, will commence work on this mine as soon as the wagon-road to the district is completed and the reduction-works are erected.

The Queen Mab, lying between the Keokuk and Argenta, has a small vein of good ore assaying $400 per ton.

The True Fissure is a strong ore vein, 4 feet wide, cropping along the strike of the vein 800 feet. Shafts to expose the vein have been sunk at various distances for 400 feet along the outcrop. The north portion is much decomposed, the ore assaying 35 per cent. in lead; the south portion has only 2½ per cent. of lead. The ore runs in silver from $50 to $150 per ton. There are said to be thousands of tons of ore in sight.

The Mountain Sheep crops out at the discovery, but is not traceable for a great distance. The ore is of high grade, containing a good deal of copper glance, and yields in silver $400 per ton. It is located 40 feet below the True Fissure, and dips to the west, as do all the veins on White-Lion Mountain.

The Silver Quartz is 50 feet above the True Fissure. The vein of ore is 8 feet wide, decomposed, bearing galena, copper, and silver, and assaying 40 per cent. in lead, and $75 to $100 in silver. The vein is traceable on the surface 700 feet, and the ore is excellent for smelting.

These last four lodes belong to Messrs. J. H. Larwill, C. Mead, A. Bassette, and J. Milligan, who are now prospecting and will develop them as fast as their means will permit. Mr. Larwill is a practical assayer, having spent, I understand, two years at Freiberg, Germany, and to him I am indebted for most of the assays.

The Condor is located on the apex of White-Lion Mountain at an altitude of 10,000 feet. It is traceable several hundred feet. The vein is 4 feet wide, and contains a good deal of barren quartz, with some small streaks of rich silver ore. But little work has been done. It belongs to Dr. Clyne & Co.

The Cleopatra is traceable 300 feet. The vein is 10 feet wide, and the ores are very much decomposed, yielding from 20 to 50 per cent. galena and $75 in silver per ton. There is an immense body of ore in sight which can be easily picked and shoveled up. The ore is fit for smelting. The owners are Dewey & Co.

The Ariadne, owned by the same company, is from 10 to 15 feet wide. The vein-matter contains iron and copper, and a small percentage of silver. The quartz is of red and brownish color. The Mark Antony, owned by Mr. Stapleton, is traceable by the croppings 400 feet. The vein is 5 feet wide at the discovery, and of solid ore, assaying from 25 to 40 per cent. in lead and $170 in silver per ton. It is located 25 feet below the Ariadne.

The Alta and Atlanta are located about 300 feet below the Mountain Sheep. This vein is traceable over 2,000 feet by irregular croppings; in some places 5 or 6 feet high, and can be seen glistening in the sun a half mile distant, resplendent with colors. The shoots of the vein are from 10 to 50 feet in width. These croppings are on a steep and rugged part of White Lion Mountain. The vein has not been well defined. The ore is about the same in kind, as that of the Mark Antony. These lodes belong to Armstrong & Co., who have taken out a small amount of ore from the south wall, but have not crossed the veins.

The Sheriff is the most northerly lode on White Lion Mountain. It crops out in shoots 20 feet wide, several hundred feet along the strike of the vein. The ore is copper-glance and sulphides, assaying $400 in silver per ton.

The Avon and Clyde are two locations on a vein, which is over 15 feet wide. The ore is argentiferous galena, average assay in silver $300 per ton. Mr. Armstrong has kept men employed all winter in taking out ore. There are now several hundred tons on the dump. They have selected and sacked for shipment ten tons of high-grade ore, taken from the foot-wall.

The Hecla, owned by the same company, is a one-foot vein of very rich ore. Mr. Armstrong has four tons sacked for shipment, which he claims will pay all his expenses for working seven men all winter. The ore is argentic sulphide. It is a blind lode, but traceable several hundred feet.

The Oneida is a solid vein, 15 inches wide, of silver sulphides and copper glance assaying from $300 to $750 in silver, and 40 per cent. lead. It is a contact-vein inclosed in smooth wall-rock. The ore is soft, much decomposed, and easily worked with pick and shovel. The strike of the vein is north and south, dipping slightly westerly into the mountain. It is a distinct continuation of the silver quartz, and is traceable for the full length of the claim.

The Mark Twain is also traceable 1,500 feet, often cropping above the surface. The wall rocks are smooth, inclosing a vein 2 feet wide. The ore is copper and lead sulphurets, yielding by assay $400 silver per ton. This vein is located 175 feet east of the Oneida, and is a plain continuation of the True Fissure.

The Niagara, Bannack, and Nero are strong croppings within the limits of the two last described claims. The Nero assays $10 in silver per ton, and is inclosed in malachite casing, assaying 40 per cent. in copper. The Niagara and Bannack lodes are inclosed in rough wall-rock, and assay $67 in silver per ton, and 40 per cent. in copper. George Tarbell & Co. own these fine lodes and are now developing them preparatory to shipping ore.

The Pride of the West is a blind lode, and belongs to Mr. Gaffney, who has five tons of selected ore sacked for shipment. The vein is irregular and pockety, varying from a seam to 5 feet in width. The ore is copper glance and galena, assaying from $300 to $400 in silver per ton.

The owners of lodes in this district are busily engaged in constructing a wagon-road, twelve miles in length, to the mines, which will be completed by the 1st of July, 1874.

Mr. Armstrong has machinery on the way for concentration and reduction works. He is now preparing the building for these works. A saw-mill will be put up at once, but owing to the great distance from railroad communication, and slowness of ox and mule trains, and the inconvenience and expense of so many middle-men and agents, the difficulties in the way of successful mining operations this season are very great.

In the *Blue-Wing district*, described at length in my last report, there is but little new development.

Mr. Stapleton has run a tunnel 250 feet in length, tapping the New Departure at a depth of 100 feet from the surface. He is now getting ready 10 tons of good ore for shipment. Since the last report he has shipped 3 tons to the Bank of California, which yielded $330.71 in coin per ton.

The Ayr, located on the same hill in limestone formation, has a small but rich vein of ore, widening to 18 inches at the bottom of a 40-foot shaft. Mr. James McCammen, the owner, shipped 4 tons of his ore last fall to the Bank of California, and received $365 per ton in coin.

The Bismarck is a blind lead in limestone, the vein being 2 feet wide. A tunnel 75 feet in length is run into the mountain-side along the vein. There are 25 tons of $100 ore on the dump, as shown from the assay-value of a ton sent to San Francisco.

The Emma is across a deep ravine on the opposite mountain. Mr. Charles Bowman, the owner of these two veins, shipped 3¼ tons to San Francisco, and received payment upon an assay-value of $133.88 per ton. This shipment, like all others from the district, passed through the hands of eight middle-men, and with sacking, freighting, unloading, re-loading, drayage, assaying, crushing, sampling, re-sacking, commission, interest, &c., three-fourths of the entire proceeds were expended, leaving him but a small profit for his labor. The vein of this mine is a foot wide, and average assays of the ore, made here by practical assayers, show about $300 per ton. Further work upon these mines depending on shipping was thought useless for the present.

The Alpha, Saint Crispin, and Erin lodes are also new locations, and are owned by J. P. Haskell. They are in granite formation. On the Alpha there is a tunnel, 3 by 6 feet in section, run along the vein 160 feet, the end of which is 60 feet below the surface. The ore is argentiferous galena, assaying $100 per ton. There are 12 tons on the dump. The Saint Crispin has a tunnel 75 feet in length and a shaft 45 feet deep. The ore is argentiferous galena, oxidized and decomposed. The width of the vein is 30 inches, and the supply of ore is irregular. There are two tons of selected ore on the dump that will average $450 per ton, according to assays. The Erin has a tunnel along the strike of the vein 75 feet in length. The vein is 2 feet wide, having smooth wall-rocks, with a streak of high grade ore from 3 to 6 inches wide, oxidized argentiferous galena, assaying $350 per ton. There are 6 tons on the dump.

The Monte Christo is a new discovery made by Joseph Arbour. It is a blind lode in granite formation, with smooth wall-rocks and 10 inches of good ore. The shaft is 40 feet deep, and the ore is oxidized argentiferous galena.

The Harriet is a new location, owned by Lilleg & Hooper. It is a 6-foot vein, with smooth granite wall-rocks. The lode does not crop out, but is traceable the whole length of the claim. Two pits have been sunk 200 feet apart, and each 8 feet in depth. The ore is decomposed, of a black-brownish color, and assays about $100 per ton. There are ten tons on the dump, and all the indications point to a large quantity easily accessible in the vein.

The Mohawk is a contact-fissure vein 4 feet wide, with granite hanging-wall and limestone foot-wall. Mr. J. C. Taylor, the owner, sunk 40 feet, following several seams of good ore before striking the main vein.

The Black Hawk, described at length in the last report, has been sunk to the depth of 375 feet. There is probably over 500 tons of low-grade ore on the dump. The ore is sulphurets of iron, with a small percentage of lead. This mine needs only facilities of transportation and cheap reduction. The supply of ore is regular and good.

The Don Juan and Luzerne are owned by Messrs. Mead, Bassett & Milligan. They are on the line between granite and limestone. The Don Juan has a shaft* running along the strike of the vein westerly 150 feet, the ore filling the entire vein, 8 feet wide, dipping into the mountain at an angle of 45°.

There are 150 tons on the dump, averaging $100 per ton, and 10 tons of selected quartz of high grade. There is an immense supply of ore in sight. The ores are sulphides and chlorides of silver.

The Luzerne, at greater altitude on the same hill, has been opened by a shaft to the depth of 35 feet on a 3-foot vein. The ore is argentiferous galena with copper stains, and assays $90 per ton. There are 75 tons on the dump. The ore is regular in quality and supply.

The Eyrie and Red Wing Lodes are on a direct line with the strike of the Bonaparte and Delmonte, in granite. On each is a shaft 45 feet deep, showing a vein 3 feet in width. The vein-stuff is similar to that of the Delmonte, containing only small streaks of high-grade ore. There are 20 tons on the dumps, the average value of the assays ranging from $75 to $100 per ton.

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*I am at a loss to understand this; it may be a clerical error, substituting "shaft" for "cut," or "strike" for "dip"—I think the former. Or the shaft may be an incline set obliquely on the plane of the lode, and so working westward on the strike as well as downward on the dip. The obscurity cannot be cleared up at this time.—R. W. R.

The Pony is an argentiferous galena vein, in the same formation and line. The ore is very much decomposed. The vein is 12 inches wide at the bottom of a 50-foot shaft. There are ten tons on the dump, of the average assay value of $75. The Delmonte is the only lode that has been vigorously worked since the last report. The ore is uniform in value and supply. There have been ninety tons sold and shipped during the past season. The two tons of Delmonte and Huron ore that were shipped in 1872 to Swansea, as an experiment, yielded 234.17 ounces in silver. The cost of shipping and working was $100 per ton. The assay made in Bannack of that shipment of Delmonte ore was $331, a good deal higher than the sampled assay in Swansea, owing to the fact that the ore could not be as thoroughly mixed and averaged by hand as by crushing and mixing. Messrs. William Peck and Con. Bray have taken a contract to sink 100 feet on the 76-foot shaft, for all the ore 40 feet on each side of the shaft. The shaft is now 132 feet deep. They are running a level for stoping on the first 50 feet. One horse does the hoisting by means of a whim. They have 40 or 50 tons of ore on the dump, at least half of which is of high grade, and will pay a handsome profit, notwithstanding all the expenses and delays of shipping. Mr. Peck shipped 35 tons of the Delmonte and 5 of the Blue Wing ores to San Francisco. The Blue Wing ore was sold in San Francisco at 50 per cent. of an assay value of $212 per ton. Meeting such poor market, he shipped the 35 tons to Hamburg, Germany, which has not yet been heard from. Ten tons of the Delmonte ore were shipped to Swansea by the owners of the lode, Sears & Smith, but they keep the return a secret. But it is a fact that the ore improves, changing to a ruby silver, as they go down. Mr. Samuel Batchelder also shipped 5 tons of the Huron ore to Swansea, and keeps the returns a secret, only, that its assay value went above 234.17 ounces in silver, and the per cent. of lead was about the same as when the first lot of the two lodes was sampled together, namely, ten per cent.

The following is said to be "a part of the analysis made at Swansea:*

	Per cent.
Silica	48.25
Copper	.85
Lead	11.43
Zinc	2.64
Iron	4.17
Oxide of manganese	3.15
Lime	6.75
Carbonic acid	12.35
Silver	.25
Gold	
	89.84

Another analysis made of the Milton Lode, 4 tons of which ore were shipped by Mr. Bostwick, the owner, was very similar, containing, however, 0.5 per cent of silver.

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*I take leave to be very suspicious of this analysis, as reported. What was the missing 11 per cent.? Sulphur? And, if so, was there no silver contained in the sulphides of lead, copper, zinc, and iron, except what was determined to be in the metallic state? How was the metallic iron determined? By calculation? Then, why not give the oxygen or sulphur by calculation, &c.?—R. W. R.

The shipment of argentiferous lead bullion made to Swansea by Mr. Roe was paid for on an assay-value of 90 ounces of silver per ton. The shipment of the same kind of bullion made by Mr. Larwill to San Francisco was sold on the basis of 147 ounces per ton, showing a balance in favor of the latter place of 57 ounces per ton. The fact that lead is lower abroad, and freight much higher to a foreign market, makes the margin of sales much greater in San Francisco.

But, the fact that these ores are sold in San Francisco, sometimes, for 50 per cent., at other times 60 and 70 per cent. of their assay-value, is an anomaly that does not accord with just dealing. It seems plain that both in California and abroad advantage has been taken of the necessities and ignorance of the Montana shippers. Smelters are too apt to make large margins for profits in buying "small lots." There is a strong probability that a better market for Montana ores will now open up in Utah. Certain, cheap, and quick transportation, and cheap concentration and reduction, are the great wants of the Territory. Railroad communications will bring these and quicken enterprise. Until the expenses of shipping, sampling, commission, and percentage of sales are saved to the miners, general success is impossible.

In the fall of 1873 Mr. J. H. Larwill shipped 23 tons of ores of the Blue Wing district, from several lodes, to Germany. Nine tons of this amount were from the east shaft on the Delmonte lode. Several months previous, two tons from the same dump were shipped to San Francisco. Payment for the first lot was made upon the basis of an assay-value of $146 per ton, for the second lot on the basis of $287 per ton.

This great discrepancy appears all the more striking when it is considered that the ore was decomposed and disintegrated and thoroughly mixed in dumping and sacking. Mr. R. J. Robertson, of Hamburg, made sale of the first lot to an "*Actiengesellschaft*" (stock company,) in Stolberg, Prussia. The second lot was sold in San Francisco by Mr. L. Faulkenau, State assayer of California.

Mr. Robertson being an authorized agent of the United Royal Smelting Works of Clausthal, Freiberg, and Eisleben, the consignment to him was unrestricted as to any one of these places; but it appears that he is also agent of other works, owned and worked by private enterprise, and under this open consignment the ores were sold to one of these private establishments much farther from the seaboard than any of the government-works. The cost per ton of sacking and transportation to Germany was $100; to San Francisco, $45. The ores shipped to Germany were sold in Stolberg at 75 per cent. and in San Francisco for 60 per cent. of their assay-value. By computation on these data, it will be seen that the shipment to Germany resulted in a slight loss, while that to San Francisco yielded a handsome profit. Besides the expenses above mentioned, there should be added the cost of mining, about $15 per ton, and for insurance, commission, discount, &c., $10 per ton. The whole cost, per ton, to Germany, was $157.

There has been but little work done in the Argenta, Birch Creek, and Vipond districts, except what was necessary to hold claims under the law.

Operations in gold-mining.—Mr. Phil. Shenan crushed 1,500 tons of ore from the Wadams lode, which yielded $32.50 per ton, 325 tons from Dakota No. 6, which yielded $47 per ton; and 250 tons from the Springfield, which yielded $30 per ton, giving a total production of these mines of $71.525 in gold, worth last season about $80,000 in currency. This result was accomplished at a cost not exceeding $5,000 for milling and mining.

The milling was done by a 5-stamp mill and arrastras and amalgamators.

The quartz in the Wadams is decomposed, and worked with pick and shovel. The lode is inclosed in quartzite and the ore-vein is irregular. The width at the bottom of a 40-foot shaft is 27 feet. From this pocket there has been mined during the past winter over 1,000 tons of good ore, better than that crushed last season. There are 50 tons of ore on the dump of Dakota No. 6. There are on this claim a shaft 325 feet deep, and a tunnel 345 feet in length—improvements made by the Butterfield Company.

Dakota No. 7 belongs to John Carhart who has raised 165 tons the past winter of very rich ore, probably the best that has ever been mined on any claim on the Dakota. He is now crushing and amalgamating it in his own mill. The shaft is 125 feet in depth and the tunnel 350 feet in length. There are 40 tons of ore on the dump of the York and 75 on the Bannack.

Merry & Co. ran 100 tons of the Saint Paul through their arrastra, obtaining $30 per ton. There are several shafts on this claim, the deepest of which is 90 feet; and there is a tunnel tapping the vein 150 feet in length. There are 100 tons on the dump and at the mill.

Extensive placer-mining has been carried on at Horse Prairie mines by the Yearian Bros., and at Bannack by the Bannack Ditch and Mining Company, superintended by N. F. Greater. Operations in both places have been highly remunerative.

Other companies at these places and at the Bald Mountain placers, and Big Hole mines, individual mining and companies of Chinamen, have generally been successful.

The production of gold was about $250,000, and the sales of silver-bearing quartz $20,000, making a total production of the precious metals for the year 1873 of $270,000, a falling off from 1872 of not less than $30,000. This fact is easily accounted for, because the furnaces have all been lying idle.

In mineral-resources Beaver Head County, in regard to drift, hydraulic and lode mining, may justly claim to rival any other county in the Territory. This is the oldest camp in the Territory, and the placer-mines continue to be productive, and will not be exhausted for many years to come. Lode-mining, on the other hand, is in its infancy.

CHAPTER X.

ALASKA.

I am indebted to Mr. A. A. Stickney, editor of the Alaska Herald, for information concerning the auriferous deposits of the Territory.

Gold-bearing quartz has been credibly reported as having been found at a number of places on the Alaskan Peninsula. A Russo-German named Greeneberg, living at Ilamla Bay, (a minor recess of Cook's Inlet,) has collected a number of specimens, which he considers of much indicative value. Mr. Benjamin Levi, now in San Francisco, has had six years' experience and observation in Alaska as a trader among the Indians. He mentions the discoveries made by Mr. Greeneberg, and says that throughout the district adjacent to Ilamla Lake the evidences of gold are unmistakable. On Kenai Peninsula James Macey began, two years ago, to prospect for gold, and met with considerable success, but was not able to remain long in the district. I understand he is now at Kadiak, and intends to return to the peninsula during the spring. Some years since the same locality was visited by a Russian engineer, who reported favorably to his government on the mineral character of the country, and accompanied his report with ample proofs of his success in prospecting. The principal discoveries on Kenai Peninsula seem to have been in the vicinity of Skillok Lake.

On Baranoff Island, (on which Sitka is situated,) during the past two years a number of ledges have been prospected, which have yielded, under assay, very promising results. The mines are distant ten to twelve miles from Sitka, and are at and near Silva Bay. In November last Bishop Seigers visited the locality. In a communication addressed to the editor of the Tacoma Tribune, Mr. Seigers gave the following as the condition of the mines at the time of his visit:

> 1. Doyle and Mooney ledge, ten miles from Sitka. Deep water for vessels of any draught. From the edge of the water to the tunnel, 50 feet; and to the croppings, 150 feet. Length of tunnel, 35 feet; and width, 6 feet. Gold is said to have been seen at the croppings. The ledge takes a downward run, and the tunnel is expected to strike the ledge 40 to 50 feet under the surface.
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> 2. Haley ledge, two miles from the shore. The latter is eleven miles from Sitka. Good anchorage and deep water 50 feet from shore. The ledge is 300 feet above the water. Side of hill not very steep. Ledge crops out 10 feet in width from east to west. Gold plainly visible; found intermixed with quartz and blue rock. Plenty of wood and water in the vicinity. No tunnel required. The shaft through the quartz is now 3 feet deep, and with every blast the gold comes out glittering. Specimens have been assayed from $246 to $7,500 to the ton.
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> 3. The Alaska Gold-Mining Company are working a third ledge, half a mile above the Haley ledge. Croppings, 6¼ feet in width. Gold glittering all over the croppings; 30 tons have been taken out, all showing gold freely, Specimen assayed by J. S. Fisk, Portland, $274 to the ton. Gold appears to be of a finer grain and less coarse than in Haley's ledge.

Since the date of Bishop Seigers's visit, work has progressed in a number of the claims, and suitable buildings have been erected looking to permanent operations. Burns & Co. have run a tunnel 75 feet, striking this ledge 40 feet below the outcroppings. From San Francisco the return of a working-test of 2 tons of rock from the "upper" ledge has been received. The return would have been quite discouraging had it not been well known that the rock sent (partly from the surface and partly from the tunnel) afforded a very unfavorable test. Judged by this fact, although the return was but $6.50 per ton, it may be considered encouraging. Assays of smaller quantities of ore from the same ledge had been made, showing, as stated in Bishop Seigers's report, $274 to the ton.

While the interest in the mines at Silver Bay was at its height, the intelligence of rich discoveries near Dease Lake, British Columbia, was received. The latter are situated about eighty miles from Buck's Bar, the highest point of boat-navigation on the Stikine River. Temporarily the effect of the excitement which has ensued, and which promises to reach a feverish stage during the coming spring, will probably be to divert attention from the quartz ledges of Alaska. Ultimately, however, the result will be to furnish from the surplus mining population of the Stikine a sufficient force to practically develop the wealth of the mines already located, and to prospect a large extent of country in Alaska as yet almost unknown.

PART II.

METALLURGICAL PROCESSES.

CHAPTER XI.

THE MINING AND METALLURGY OF QUICKSILVER.

The ore[*] from which quicksilver is chiefly produced, and, in fact, the only one of importance in metallurgy, is the sulphuret of mercury or cinnabar. This ore seldom if ever occurs in true-fissure veins. Sometimes, as at Almaden, in Spain, (according to some accounts,) it occurs in a vein-like formation, which it impregnates to a greater or less extent; and this formation has well-defined boundaries, so that the deposit can be worked with great regularity. This is also true, to a less extent, of the deposit at Idria, in Austria, and at the Redington quicksilver mine in California; but the generality of deposits in this State and elsewhere are very irregular in their occurrence. To the miner the nature of the deposit is only of interest in so far as it directs the methods of exploration; but as the occurrence of deposits may throw some light upon the nature of new deposits, and thereby prove a guide in the method of exploring, it may not be superfluous to give here a concise account of the geological features of some of the best known mines.

FOREIGN DEPOSITS OF QUICKSILVER ORES.

Almaden.—Concerning the nature of the quicksilver deposits at Almaden, in Spain, opinions differ. Some regard them as true veins; others as bed-like impregnations similar to those of Idria, in Austria. The strata in which the deposits occur belong to the Upper Silurian; the immediate wall-rock is a black, carbonaceous slate and quartzite, with which hard, fine-grained sandstone alternate, but which contain no ore. Near the surface the dip of the bodies is 60° to 70°; but in depth it is nearly vertical. The deposits are almost entirely composed of quartz or quartzose sandstone, intermixed with cinnabar. The latter sometimes impregnates the quartz and sometimes is found in solid masses. The body of ore is sometimes traversed by clefts which contain native mercury. The deposits are called "beds" by De Prada, because they dip with the Silurian slates. He thinks, however, that the ore has penetrated between the slates with some choice of way. Le Play considers the deposits to be veins, and found that they were separated on both sides from the country rock by distinct quartz selvages. He also found pieces of a volcanic rock intermixed with the mass, which rock occurs in the neighborhood, and with the eruption of which he believes the veins to be connected. Spanish mining engineers, however, deny these deductions; and the preponderance of testimony seems to be in favor of considering these deposits as beds impregnated with cinnabar.

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[*] For this chapter I am indebted to Mr. Louis Janin, jr., mining engineer, well known upon the Pacific coast as a skillful and experienced metallurgist. The present general activity in exploring for new deposits of quicksilver, and the peculiar risks which have heretofore attended its production as a commercial enterprise, render a trustworthy discussion of the subject especially timely, and therefore doubly interesting and valuable. This admirable paper from Mr. Janin, together with the survey of actual operations in California furnished by Mr. Yale in a preceding chapter, will, I am confident, be heartily welcomed by practical miners as well as professional metallurgists. The readiness and generosity with which engineers of scientific reputation and high standing have from time to time co-operated to disseminate such information among our mining communities have contributed much to the fruitfulness of my own labors, and laid not me only, but the country as well, under lasting obligations.—R. W. R.

Idria.—At Idria, in Austria, the deposits are much more irregular than at Almaden. They are of uncertain age, and are undoubtedly bed-like impregnations. The cinnabar occurs in the middle limestone deposit, partly disseminated in the calcareous slates, partly as pockets in black limestone, or as fillings of its fissures of stratification. But the principal deposit is in one fissure, hence called the metalliferous seam. Much of the ore is highly bituminous.

Ripa.—At Ripa, in Modena, the mountains consist of a variety of crystalline schists. Within the common mica-schist occurs a white, silky variety, which passes into talc-schist, containing numerous layers of quartz. In these last, cinnabar is found impregnating the entire mass, and in the fissures of foliation. The cinnabar has probably penetrated the rock long subsequent to its formation, so that the deposit must be regarded as an impregnation in the fullest sense of the term. The difference of character between the mica-schist containing the cinnabar and that which is free of ore, is probably a consequence of the same influence which caused the impregnations.

Palatinate.—In the Palatinate the peculiarity of the quicksilver deposits lies in the fact that the ores are found, as a rule, only at moderate depth, and distributed in the numerous fissures of the rock. This method of occurrence seems to prove that they owe their origin to a process of sublimation. A tolerably extended district was subjected for a considerable period to these sublimations, which penetrated the fissures wherever a possibility existed. They were deposited at a certain level by a certain temperature, and their precipitation was influenced by certain rocks more than by others.

Vall' Alta.—At Vall' Alta, in Venetia, the cinnabar occurs in a calcareous schist in contact with quartzose porphyry. The latter also is impregnated with the ore; and the occurrence of the cinnabar seems to be connected with the eruption of the porphyry. The whole mass of ore-bearing ground is traversed in every direction by small, even minute, seams of cinnabar and gypsum. While the origin of the ore is a matter of doubt, there are a number of facts which lead some to believe that the ore must have been deposited from a solution. Of this there is, however, no absolute proof.

DEPOSITS OF QUICKSILVER-ORE IN CALIFORNIA.

New Almaden.—The New Almaden mines, consisting of a number of segregated deposits, are chiefly in a belt of altered slates with beds of serpentine on either side, though not continuous. The main ridge seems to be made up of a series of metamorphic slates, sandstones, and serpentines. The slates belong to the Cretaceous age; but the occurrence of cinnabar in California is confined, so far as the inclosing rocks are concerned, to no particular age. At the main opening on the property in question, the ore occupied a series of irregular cavities confined within a comparatively small space, both in area and in depth. The "chimneys" occur without any approach to regularity and often without any apparent connection with one another. It has frequently happened, in the history of this mine, that there was no ore "in sight," and other deposits were found after groping blindly about.

At the Enriquita mine a series of irregular bodies of cinnabar, and also a number of nearly parallel seams, occur in a soft, decomposed ochreous ground, containing brecciated particles of siliceous limestone, and pieces of jaspery and chalcedonic rocks.

New Idria.—The New Idria property, in Fresno County, consists of a number of mines along a course of some three miles, between the San Carlos and the New Idria proper—the names of the principal openings.

At the San Carlos, the rock is a whitish granular sandstone, sometimes in its original condition, but generally metamorphosed to a greater or less extent. The cinnabar is most irregularly diffused through the rock, so much so that there is no system or regularity to be traced in the workings.

At the Aurora mine (intervening between the two above mentioned,) the rock is an exceedingly hard siliceous material, colored green in places by nickel, with ferruginous portions and a little cinnabar scattered through it in specks.

At the New Idria mine the rocks are very varied, but consist chiefly of sandstone and slate in different stages of metamorphosis. In one of the main tunnels the rock is a dark, somewhat bituminous silico-argillaceous slate, much fractured and shivered, filled with slickensides, and so disturbed that it would be impossible to make out its average dip and direction. In other places the rock is very siliceous, and broken up into a sort of breccia, the cinnabar filling the spaces between the fragments.

Pine Mountain.—About Pine Mountain, Lake County, the region is made up of highly metamorphic rock, including serpentine in immense quantities, and other rocks similar in association and in lithological character to the mercury-bearing rocks of New Almaden and New Idria; and, as was to be expected, quite a large number of deposits of cinnabar have been discovered here.

THE MINING OF QUICKSILVER-ORES.

The general features of the occurrence of the ore in all the deposits known to me leave no doubt in my mind that the cinnabar deposits belong to that class known as ore-impregnations, and this means that they belong to the most irregular of all ore-bodies.

While the partially-developed contents of a true vein may be estimated with tolerable certainty, (say when only two sides of a body are cut,) and its regularity can be depended upon without assuming much risk, there can be no reliance placed upon any ore-impregnation until the body is cut on all sides.

Even when the slates which are impregnated with cinnabar can be definitely traced for a considerable distance, it is often found that these slates are impregnated in a very irregular manner.

Sometimes the cinnabar forms solid veins of a width varying from an inch to several feet, and in one claim I have seen several such veins parallel to one another; but none of them were continuous in length or depth.

In other places the cinnabar is gathered in large, rich bodies of high-grade ore, and these bodies are apparently without any connection with one another. Sometimes the deposit is composed of a loose, earthy material, colored by the presence of iron, and traversed in many directions by small, rich seams of cinnabar, and containing also detached bunches of ore.

These irregularities in the occurrence of cinnabar, and the uncertainty of its continuance either in depth or laterally, give rise to the irregular method of mining which is observable in nearly all quicksilver deposits.

If a given deposit has the form of a vein, so that its continuance in depth may be presumed, and if its topographical features permit, then the most advisable course may be to work it by means of tunnels; but when the deposit consists rather of a series of "pockets," which have no regularity of occurrence, then the cheaper method of mining must be foregone, and ultimate economy must be sacrificed to present necessity. The exploration must be conducted in ore as far as this is possible. Not until ore is found in quantity, and its extent is sufficiently proven, can any tunneling be permitted to effect its cheaper extraction.

A deposit should always be well proven by exploratory works. There should always be enough ore ahead to keep the furnaces busy for at least six months.

In general, there is nothing peculiar in the mining of quicksilver-ores except that which is incident to the irregularity of their occurrence. The method to be pursued depends chiefly upon the judgment and estimates of the engineer in charge, and the amount of working capital furnished him.

Mining in California differs from that in other countries chiefly in the fact that men of small means often engage in large and extensive enterprises without counting the cost. It is seldom that an adequate amount of money is used to insure economy in the work. The mills or reduction-works are generally built before the mines are thoroughly tested, and then the owners, besides the natural disadvantages of an unproven deposit, have to contend with that greater disadvantage, indebtedness.

THE METALLURGY OF QUICKSILVER-ORES.

The theory of the reduction of quicksilver from its ores is simple; in fact, that of no metal is more so. And yet it has its peculiarities and a variety of practical difficulties, which must be known in order to be overcome.

As cinnabar is the only ore of importance in the metallurgy of quicksilver, it is to the reduction of this ore that the present discussion will be confined.

Cinnabar in a state of purity is a sulphuret of quicksilver, containing in 100 parts 13.79 parts of sulphur and 86.21 parts of quicksilver. Although it has been by no means uncommon to find large masses of it which contained 60 per cent. of quicksilver and upward, the generality of this ore as extracted carries below 10 per cent., and the majority of the small deposits in California do not average over 2 per cent. Ore of a much lower grade than the above can be and is worked in different parts of the world. The lowest grade of ore which can be profitably worked is governed by the cost of mining and reduction, and by the ruling price of quicksilver; and as these items vary at different places and at different times, no definite limit can be assigned.

Although cinnabar is generally accompanied by a slight admixture of impurities, the percentage of these is very small. The difference in the grades of the ore depends upon the greater or smaller proportion of the gangue or sterile rock with which it is intermixed.

The absence of all injurious impurities greatly simplifies the process of reduction. The object to be attained is, first, separation of the sulphur from the quicksilver, and, secondly, since in this attempt the quicksilver is vaporized, to recondense the fumes of the metal.

Two systems, with their various modifications, are in use.

The one is to burn the powdered ore in closed vessels, (retorts,) having first intermixed with it 50 per cent. of its weight either of lime or of iron filings. Under the influence of the heat the sulphur combines with the lime or iron, and the fumes of quicksilver pass off from the retorts into the necessary condensing-apparatus.

The second system is to burn the ore in furnaces. Under the admission of air the sulphur is converted into sulphurous-acid gas, and the quicksilver is set free as a vapor. These vapors and gases, and also all the gases arising from the combustion of the fuel, pass from the furnaces into proper condensing-chambers, and there the quicksilver is condensed, while the gases pass off through a chimney beyond.

In the following pages the attempt is made to show the salient features and the facts taught in each system and each variety of furnace that merits notice.

These descriptions are made as brief as is compatible with clearness and with the endeavor to retain all facts of interest. Although it is not at all likely that certain of the furnaces described will ever be introduced elsewhere than where they are now used, it is necessary to describe their working in order to give weight to the deductions drawn. In every case where it was possible, the endeavor has been made to substantiate theoretical conclusions by actual results.

FIRST SYSTEM—CLOSED VESSELS.

Of the various kinds of retorts now or heretofore in use, the iron retorts proposed by Dr. Ure are the only ones worthy of mention. They were originally introduced, I believe, at Moschellandsberg, in the Palatinate, but they did not turn out satisfactorily.

The system, owing to its apparent simplicity, attracted considerable attention, and, soon after their introduction, the director of the works at Idria was authorized to give them a thorough trial, and a certain sum of money was allowed him for the purpose. The experiment was made upon the rich ores of the mine, but was not entirely conclusive, as, after the sixth charge, the retorts were ruined, and the funds at his disposal were expended. They have not been tried again.

In 1861 the director informed me that the percentage extracted was high, but that the costs for labor and fuel, as well as the cost of previous preparation, were so great as to overbalance the value of the extra amount of quicksilver obtained.

Dr. Ure, in his well-known dictionary, pointed out, very justly, the great imperfections of all the then existing systems for the reduction of quicksilver-ores, and claimed such decided advantages for his retorts that the owners of many quicksilver deposits have been induced to give them a trial. The results have always proved that the advantages claimed were more theoretical than practical. My own experience with retorts has led me to coincide with the views of the director at Idria, with the notable exception that the percentage of yield is not invariably high. In fact, the percentage of metal extracted, unless the burning is protracted beyond remunerative limits, is not much greater than can be obtained by other means. Furthermore, in the manner in which the retorts must be worked practically in order to realize any profit from the ores, they are subjected to such variations in temperature that no retort will last more than a short length of time; and, therefore, a considerable number of extra retorts must be kept on hand.

In California these retorts were once in use at the Almaden mine, but were soon replaced by an intermittent furnace. At the Enriqueta mine there were eighteen retorts, of which at least six were constantly out of order, and finally a furnace was built to replace them. The last place where they were introduced was at the Phœnix mine, and here they have been done away with, and a Knox furnace is used.

It is not necessary, in view of these facts, to enter into the details of the construction and the working results of the iron retorts. But it must be said in their favor that, when very rich ore is worked, (containing 20 per cent. and upward of quicksilver,) it may be advisable to use these retorts if they are on hand, provided that the ore, crushed more or less fine, is mixed with at least one-half its weight in lime, and is carefully burned from 8 to 12 hours, in charges not exceeding 600 pounds in weight. If the retorts are not already in use, such ore can be well treated in other apparatus.

At the Phœnix mine the charge for a retort, say 600 pounds, was placed in two sheet-iron pans, which fill the lower half of the retort, leaving the upper half free. If the retorts are filled too high, the tension of the vapor is such that much of the fumes of cinnabar might be driven out into the air before they come into contact with the lime, and might thus pass off undecomposed.

On the whole, as sufficiently appears from the foregoing, retorts cannot be recommended.

SECOND SYSTEM—ROASTING IN FURNACES

In this system the object to be attained is the same for all furnaces in use. The ore is burned at a comparatively high degree of temperature with an excess of air. The cinnabar is volatilized under the influence of heat, and the sulphur oxidized by the undecomposed air admitted into the furnace is converted into sulphurous acid gas, while the quicksilver passes off in a state of vapor. All the gases and fumes from the ore, as well as the products of combustion of the fuel, are drawn off, either by natural or by artificial draught, into neighboring condensing-chambers, where the quicksilver is caught, more or less mixed with impurities, while the gases pass off beyond, through a chimney.

The furnaces are of various forms, and the condensing-apparatus also is of different patterns. The roasting of the ore, to free it from all the quicksilver present, is easily attained with ordinary precaution, so that the changes in the form of the furnaces which have been introduced from time to time, were intended to effect rather an economy of labor and of fuel than a more perfect roasting.

A high percentage of yield depends chiefly upon the condensers, and can only be obtained when good condensing-apparatus is used. All kinds are more or less unsatisfactory, and a solution of all the difficulties encountered is yet to be found. Various methods are used, and new ones are to be tried. It is within the province of this chapter to describe a number of them.

The furnaces used are of two kinds, intermittent and perpetual. In the former a charge (generally a large one) is placed in the furnace and burned. After a certain time the charge becomes cool and is withdrawn, and the furnace is ready for another one. In a perpetual furnace, however, small charges are continually fed into the furnace at stated intervals, while the ore which is burned is withdrawn without interrupting the march of the operation. There are a number of furnaces belonging to each of the above systems. They are best described separately.

Intermittent furnaces.—Of this description of furnaces the kinds now in use are the Bustamente furnace of Almaden, the Leopoldi or Idria furnace of Idria, and the large intermittent furnaces used in California. These differ slightly in their furnace-compartment. The condensing-chambers of the Idria and the California furnaces resemble one another closely, but they differ entirely from the apparatus used at Almaden.

The Bustamente furnace.—This was introduced over two hundred years ago, and therefore has been longer in use than any other; but it is nowhere employed except at Almaden, in Spain. It was tried at Idria, but was soon modified into the present style of furnace. At Almaden, however, it continues to hold its own against all proposed innovations, and actually, whatever may be the reason, seems to give better returns than the furnaces of Idria, which are also used at that place, although the percentage of the yield does not compare favorably with the yield obtained at Idria.

The furnace consists of a cylindrical shaft, say 6 feet in diameter and 25 feet high. This shaft is arched over above, leaving, however, a hole through which some of the ore is charged. About 9 or 10 feet from the top several perforated arches divide the furnace into two compartments, the upper being for ore and the lower for fuel.

Immediately below the top of the upper compartment there are six flues leading to two small condensing-chambers, each of which receives three flues. Each of these chambers has six flues on its farther side, and through each of these flues a portion of the fumes and gases enters a line of clay crucibles or *aludeln*, which form the peculiar distillatory apparatus of these furnaces. These *aludeln* rest upon two benches inclined toward each other, and together aggregating some 66 feet in length. Each file of *aludeln* rests over a long narrow opening formed in the bench, which leads to a central channel at right angles to the files, from whence the quicksilver, as it flows out, is caught in proper receptacles. The central channel is at the junction of the two benches, and is inclined slightly to one side. In all there are twelve files of *aludeln*, arranged in two sets of six each. There are, say, forty-four in each row, making five hundred and twenty-eight in all. Each *aludel* is about 18 inches in length, 10 inches wide in the middle, and about 6 inches wide at each end where it fits into the next. The joints are luted with moistened ashes. In each *aludel* is a small hole, which allows what quicksilver is condensed to flow into the gutter leading to the central channel.

After passing down the first half of the files of *aludeln*, the gases, fumes, &c., pass up the opposite half into a chimney, which in itself forms a condensing-chamber, and where some quicksilver is caught before the fumes finally make their exit into the open air. The ore is piled up on the dividing arches in the furnace. The larger pieces of the poor ore (sandstone impregnated with cinnabar) form the first layer. Upon this is put the ordinary average ore, and then come the rich and the finer fragments of the poor ores. Finally, the residues from the condensers and the fine dirt, made into sun-dried bricks, complete the charge.

The ore is put into a furnace chiefly by means of a side entrance to the upper compartment. When the charge is ready, this aperture and the opening on top are closed and the fire is kindled. The heat is raised gradually and the fire is maintained from twelve to eighteen hours. Connected with the fire-chamber is a side chimney, which carries off some of the smoke from the fuel; but most of the products of combustion pass up through the ore into the *aludeln* and give rise to the soot which is afterward found intermixed with the quicksilver of Almaden.

The period of burning and distilling the quicksilver lasts three days.

On the fourth day the furnace is recharged. the *aludeln* are taken up, emptied of their contents into the main gutter or channel, and then rearranged for the following charge.

Besides these furnaces there are a number of Idria furnaces in use at Almaden, which will be described in detail further on.

The weight for a charge for a Bustamente furnace is 800 to 900 arrobas of 25 pounds; that for an Idria furnace is 2,000 to 2,200 arrobas. As the ore produced from the mine is of different grades, each charge is composed of a mixture of rich and poor ores, in such proportions as to insure a nearly uniform result. The weight of the ore and its value are generally estimated, and each charge is made up according to the judgment of the head-charger, whose main object seems to be, as I have said, to secure a uniform yield.

The following is an estimate of the different quantities of ore making up a charge at Almaden:

Quality of ore.	Furnaces.	
	For Bustamente.	For Idria.
	Arrobas.	*Arrobas.*
High-grade ore, yielding 20 per cent	170	400
China, or average ore, yielding 6 per cent	400	1,000
Poor ores, yielding ½ per cent	120	300
Bricks, made of fine dirt, yielding 5 to 6 per cent	150	450
Total number of arrobas	840	2,150

Consequently the capacities of the two kinds of furnaces are to each other as 1:2.56.

For each campaign of six months there are, say, 1,120 charges worked in the Bustamente furnace against 70 charges worked in the Idria furnace. The quantity of each kind of ore is as follows, in quintals.

Class of ore.	Bustamente furnace.	Idria furnace.	Total.	Yield.
	Quintals.	*Quintals.*	*Quintals.*	*Quintals.*
Rich ore, (metal)	47,600	3,500	51,100	10,220
Medium ore, (China)	112,000	8,750	120,750	7,245
Poor ore, (Solera)	33,600	2,625	36,225	181
Adobes, &c., (Baciscos)	42,000	3,937	45,937	2,296
Total	235,200	18,812	254,012	19,942

The average yield of all the ore is therefore about 7.85 per cent. This yield and the quantity worked of each kind of ore varies but little for each campaign. But this percentage is obtained by dividing the total amount of quicksilver produced by the supposed number of tons worked, and then estimating that each particular kind of ore yielded the amount indicated. Actual experiments, however, conducted with more or less accuracy, showed the following results for the ore worked during the campaign of 1856:

Average assay value:	Per cent.
Metal, (rich ore)	38.576
Requiebro, (medium ores)	9.904
Solera, (poor ores)	2.230
Sundries, bricks mixed with residues from *aludeln*	17.790
The same without the residues	5.110

The ore was mixed in such proportion as to yield, for the total, an average assay value of 13.87 per cent.

Comparing the yield obtained with the amount worked it was found that the loss in the Bustamente furnace was 49.82 per cent., and the loss in the Idria furnace was 53.40 per cent., and the average was 50.25 per cent.

In 1840 it was ascertained in a comparison between the two furnaces that the relative cost of working the Idria and Bustamente furnaces for equal quantities of metal produced was as 1 : 1.48. At a later date a comparison showed the relative cost to be as 1 : 1.35; viz: cost of producing 100 pounds metal in the Bustamente furnace, 8.95 reales; cost of producing 100 pounds metal in the Idria furnace, 6.63 reales. It was also found that for the same quantity of metal produced, the Bustamente furnace required 10 per cent. more fuel than the Idria furnace.

In order to bring more prominently into view the fact brought out by the above figures, I give the following resumé:

1st. The average amount worked per each campaign is about 12,200½ tons of ore, which yield an average of 7.85 per cent., or 997½ tons of metal; of the amount of ore worked there is about 20 per cent. of rich ore which yields 20 per cent. of metal; and about 48 per cent. of medium ores which yield 6 per cent. of metal; and about 14 per cent. of poor ores which yield ½ per cent. of metal; and about 18 per cent. of fine dirt, &c., which yields 5 per cent. of metal.

2d. The relative weight of the charges of the two furnaces is as 1 : 2.56.

3d. The relative cost of working the two furnaces is as 1 : 1.35; of this difference the extra cost of fuel amounts to 10 per cent., and other costs, labor, &c., 25 per cent.

4th. The relative yield of the two furnaces is as 46.60 : 50.18. That is, in working the same ore at an increased cost of 35 per cent. for a given amount of metal produced, the yield of the Bustamente furnace exceeds that of the Idria furnace by 3.58 per cent.

It is thus seen that the cost of fuel is greater in the Bustamente furnace than in the Idria by 10 per cent. This may partly be due to the fact that a portion of the products of combustion from the fuel—and therefore a portion of the heat—escapes through the side chamber connected with the fire-place in the former furnace; but the chief cause must be in the fact that to work up a given amount of ore the proportional number of charges required by the Bustamente furnace is to that required by the Idria as 5 to 2; so that the Idria furnace would be cooled down but once while working up this ore, whereas the Bustamente furnace would have to be cooled down four times, thereby causing a considerable loss of fuel in heating up the brick-work so many times. Consequently, other things being equal, it seems that an intermittent furnace should work up as large a quantity of ore in one charge as possible.

The remainder of the excess of cost in the Almaden furnace is chiefly due to the difference in the condensing appliances, since the *aludeln* of the Almaden furnace, must be handled separately at the end of each charge, necessarily involving considerable labor. Furthermore, these *aludeln* are liable to breakage, either in the frequent handling they require, or on account of the difference in the temperature to which they are subjected by night and by day. In order, moreover, to resist the corrosive action of the acids formed in them, and to prevent the permeation of the quicksilver under considerable tension, these *aludeln* (and clay retorts of all kinds,) should possess considerable fineness and regularity of grain; but in proportion as the above object is attained is their liability to crack increased. On this account many *aludeln* are lost, thereby entailing a considerable cost.

Taking the above in connection with the fact that (admitting the results obtained to be correct) the Bustamente furnace produces 3.58 per cent. more from the ore worked than the Idria furnace, it will be seen that this small extra percentage more than covers the extra cost of production; for assuming that one ton (of 2,000 pounds) of ore was worked by each of the above methods, and that the assay-value of this ore was 14 per cent., then the production of the Bustamente furnace, taking the yield at 50.18 per cent. of the assay, would be, say, 140½ pounds; and in the Idria furnace, at 46.6 per cent., yield 130½ pounds; making a difference of 10 pounds. Now, the cost of producing 100 pounds of metal in the Bustamente furnace is 8.95 reales, and in the Idria furnace 6.60 reales. Consequently, the cost of working one ton of ore in the Bustamente furnace, which produces 140½ pounds of metal, would be 12.57 reales; and the cost of the same quantity of ore in the Idria furnace, which produces 130½ pounds of metal, would be 8.61 reales; being a balance against the Bustamete furnace of only 3.96 reales. But the difference of the yield, (10 pounds,) estimating the value at 4 reals to the pound, would be for the 10 pounds 40 reales; making a gain per ton worked of, say, 36 reales. This shows the great advantage of producing a higher percentage of yield even at an increased cost. The amount of advantage to be derived, however, depends upon the assay-value of the ore, and the selling price of quicksilver.

In general, the cost of reduction is small. It is the mining cost that devours the profits.

Although from the foregoing it would seem that the Idria furnace is not as profitable as the Almaden (or Bustamente) furnace, this must by no means be taken as proven. Further on it will be shown that at Idria, in working ores averaging 3 26 per cent. by assay, the yield of the Idria furnace gives 73 per cent. of this value. Furthermore, the Almaden furnace did not succeed at Idria. Without entering into details, the following conclusions may be drawn:

1. A defective system in the hands of those who thoroughly understand all its features is likely to prove more profitable than a better system under ignorant management.

2. The difference in the nature of the ores, as met with in different deposits, would cause a dissimilarity in the yield of the ores, when worked by the same system. Any given method might not be the most desirable for every deposit.

It will have been seen that the poorer and richer ores are mixed together. This is not due solely to the fact that the poorer ores worked by themselves might give too small a yield to be profitable; but because experience has taught the managers that ores of a higher average cannot be profitably worked in the Almaden furnaces. Probably the reason is this: a given amount of ore is worked in each charge and for a definite length of time.

The numbers and capacity of the *aludeln* are constant; and it has been found that they will not properly condense more than a given amount of fumes—say an amount equivalent to a yield of 8 per cent. of quicksilver for the charge worked. It seems to me that so long as the amount of quicksilver fumes does not surpass the necessary limits, it is immaterial whether the ore is richer than the average or not.

Theoretically considered, this system of condensation is very defective and open to many objections. While the figures given show the yield of the ore to be of a higher percentage than has generally been conceded, it is obvious that the loss must be heavy.

The Leopoldi furnace of Idria.—This furnace, compared with the Bustamente, of Almaden, shows considerable resemblance in the furnace compartment; but the condensers consist of a series of brick chambers built together, but separated by partition walls.

The shaft is cylindrical, and is divided into three compartments by two perforated arches. In the lowest compartment is the fire-place. In the middle compartment, resting upon the arch, are placed, first, the large pieces of low-grade ore, and upon these other smaller pieces of ore, which are richer in quicksilver. Upon the upper arch are placed rows of clay vessels, containing the fine dirt, sometimes very rich in quicksilver, and also the soot and other rich residues from the condensing-chambers. The top of the shaft is arched over. Immediately below this arch are the side openings of flues, through which the fumes and gases pass into the condensers. The weight of a charge is about 25 to 30 tons.

It will be seen that the method of arranging the charge in this furnace is like that in the Almaden furnace. The larger pieces of poor ore are so placed as to receive the greatest amount of heat, and the better class of ores are placed farther from the flames. There are several reasons for this arrangement. In the first place, the poor pieces are of large size, say 10 to 15 inches in diameter, and consequently should be placed at the bottom. To break them into smaller pieces would involve labor and effect no particular division of the rock into waste and ore. In the second place, in order to drive out the small percentage of quicksilver they contain, a high temperature is necessary, that the heat may penetrate to the interior of the mass. Thirdly, the richer rocks, if placed in contact with the fire, might agglomerate, and thereby impede the draught. This is particularly true of such ores as are bituminous. Furthermore, on account of their greater percentage, the rich ores are broken into pieces not exceeding 3 to 4 inches in diameter, so that the cinnabar may be driven off readily.

The charging of the furnace is effected very rapidly, as forty men taken from the mine are engaged on each furnace. The work is finished in one and a half to three hours. A light fire is then made, so that the temperature of the furnace shall rise gradually, and that the steam arising from the heated ore may pass off before the quicksilver begins to distill. The fire is gradually increased by adding more fuel, until the necessary temperature is reached—say in twelve to twenty hours, according to the previous coolness or warmth of the furnace.

Within a few hours after the necessary temperature is obtained, the mercury from the rich residues placed on the upper arch begins to flow from the condensers; but it requires, say twelve hours for the ore to become sufficiently heated to part with its mercury.

Fresh air is admitted into the ore-compartment of the furnace by side openings, so that the cinnabar can be readily decomposed, the sulphur being converted into sulphurous acid gas and the quicksilver passing off in vapors.

As soon as the furnace is sufficiently heated, the doors of the fire-place and of the ash-pit are closed, and the furnace is left to itself. The burning of a charge requires seven days. During the first day the furnace is charged, and the ore is heated to the necessary degree of temperature. Three days are required for the thorough distillation of the ore, and three days more for the furnace to cool sufficiently to be discharged.

To each furnace there are attached seven condensing-chambers. Each of these is about 30 feet high, with a rectangular section at the bottom of 8 by 12 feet. The fumes, &c., from the furnaces pass from one chamber to another through openings in the partition walls. Finally, the fumes pass off through a chimney.

Besides the quicksilver which is condensed in these chambers, there collects a considerable amount of soot, which settles upon the walls and the bottom of the chambers.

This soot is generally swept out of the furnaces once a year. It contains a large amount of quicksilver, which is partially separated from the mass by simply rubbing the soot with wooden hoes. The particles of quicksilver collect, and flow down an incline plane to the bottom into proper receptacles. The residue from this operation still contains 15 to 20 per cent. of quicksilver, and is mixed with lime and placed in the earthen vessels above mentioned, to be re-burned.

This soot, which is produced in considerable quantities where the ores are roasted, is a mechanical admixture of fine dirt, which is drawn in from the furnace, particles of unconsumed carbon, some ash, some undecomposed cinnabar, various other impurities, and minute particles of the metal. In appearance it resembles lampblack, and is generally taken in a moist condition from the chambers, owing to the steam introduced from the wood and ore. The best method of reducing the soot is to burn it in retorts, after mixing with lime.

Before entering into further details concerning the workings of these furnaces or the results obtained by the use of brick condensers, it will be well to describe the intermittent furnaces of California, as the condensers in use are similar to those of Idria.

Intermittent furnaces of California.—These furnaces are in use at the leading quicksilver-mines of California, and although there are slight modifications introduced at each place, they differ in no essential particular except size.

The compartment into which the ore is charged consists of a rectangular chamber about 12 feet square at the bottom and from 12 to 15 feet high. The charge consists of alternating layers of ore and adobes of fine dirt, containing from 3 to 10 per cent. of metal. There are usually four layers of adobes in the height of the charge, and they are so arranged as to form flues for the more ready passage of the flame and heat through the mass of ore. They also prevent the charge from settling into a compact mass, and allow some room for the expansion of the charge under the influence of heat. The charge is covered over with bricks without mortar, but a layer of mud is spread over these, whereby the fumes are prevented from escaping. This covering, however, must be watched, as it sometimes cracks open and requires replastering.

The fire-place is on one side of the ore-compartment, and the condensers on the other. These three divisions of the furnace are separated by two perforated walls of fire-brick. The condensers, like those of Idria, are of brick and equally large; some, in fact, are much higher. The top of the chambers consists of iron plates, kept cool by a constant flow of water. To the brick condensers others of wood are sometimes attached. A long flue generally connects the condensers with the chimney. In order to increase the draught, a recess is sometimes connected with this flue, in which a fire can be kindled when necessary.

A charge of one of these furnaces varies in weight from 50 to 80 tons. The time required to burn a charge is from five to seven days.

The cost of labor in charging and discharging a furnace does not differ materially at the several mines; but the amount of fuel burned varies between wide limits, and depends chiefly upon the nature of the ore. At the Redington mine an 80-ton charge will not consume much over two and a half cords of wood, whereas at the New Idria mine the consumption is about eight cords for a 60-ton furnace. The ore of the Redington mine contains a notable quantity of arsenical and iron pyrites, which, in burning, assist greatly in keeping up the heat. Besides, the ores of this mine are also more porous than those of New Idria, and the cinnabar is hence driven off more readily.

The charging and discharging is sometimes performed under contract and sometimes by labor under proper supervision. At the New Idria mines the discharging is done by contract, but the charging is deemed of too much importance to be left without supervision. At New Almaden the labor is contracted for. The total cost of burning the ore will vary from 75 cents to $1.75 per ton of ore. Under similar circumstances the difference of cost seems to be decidedly in favor of large charges, with respect to both the amount of fuel required and the labor.

There are no records to show what percentage of ore treated is lost. Probably this amounts to fully 40 per cent. of the contents in quicksilver, if not more, although it is claimed that as high as 90 per cent. has been extracted.

A comparison between the Idria and the California system will show the resemblance between the condensing-chambers, and also the difference in the furnace-compartment.

In Idria it requires the labor of forty men three hours to charge a 30-ton furnace; in California twelve men will charge a 60-ton furnace in eight hours, or, in the same space of time, sixteen men will charge an 80-ton furnace. In the Idria furnace the ore rests upon arches, which may crumble beneath its weight, and thereby cause considerable loss and expense; in the California system this difficulty is avoided. In the Idria furnace it requires as much time to burn a charge of 30 tons of 3 to 4 per cent. ore as is necessary in California to burn a charge of 80 tons of 5 to 10 per cent. ore. In Idria the yield of the ore is 79 per cent. of its contents; in California it is probably not over 60 per cent. This difference, however, is not due to the difference in the system of burning, but to the fact that the relative amount of condensing space is less in the California than in the Idria furnaces for the amount of metal produced, and that the great skill and knowledge manifested in Idria are yet wanting in California.

The cost of working a given amount of ore is in favor of the California system, notwithstanding the extra cost of labor and material used.

Brick condensing chambers.—As brick condensing-chambers are likely to be used for many years to come, it may be well to point out certain facts relative to their workings.

When a charge is being burned after a furnace has been idle for sometime, and therefore has become thoroughly cool, it is noticeable that the largest deposition of mercurial soot and vapors takes place in the first chamber, and the amount decreases in the other chambers in proportion to their distance from the fire; but after a number of charges have been burned, and the brick-work retains a constantly increasing amount of heat, it is found that the first chamber receives a less proportion of mercury, and that the fumes are caught farther along. At Idria, in the regular march of operations, it is the third of the seven chambers that gives on an average the greatest production.

The above fact shows the impossibility of condensing the fumes when the condensers are too warm. It shows also the great retentive power that bricks have for heat; and therein lies one of the greatest objections to their use.

In addition to a similar experience in California, it has here been found that enormous quantities of quicksilver can be lost by its forcing its way even through the best made bottoms of condensing-chambers, as well as through almost imperceptible cracks in the walls, probably resulting from frequent contraction and expansion.

Beneath the old furnaces at New Almaden, some 2,000 flasks were recovered by washing out the ground to a depth of 30 feet and upward, (and I may here say that I have recovered many flasks from washing out the ground in front of benches of retorts.)

The furnaces in California are built upon arches, and near the bottom of these arches pieces of sheet-iron are placed in the masonry which catch the quicksilver as it filters through, and conducts it to a basin.

It was also found that every additional chamber added to existing condensers proved of value in retaining quicksilver-fumes, so that the actual condensing space of these furnaces is greater than in the Idria furnace—a necessity arising from the greater percentage and quantity of the ore worked. It has also been found that not only is *space* a necessary requisite, but that condensing *surface* is desirable. A few very large chambers are not so efficacious as the same space divided up into a greater number of compartments by partition-walls. The fumes must be forced in their passage through condensers, to come into contact with as much surface as possible; otherwise the minute particles of quicksilver might be carried away in the current of gases.

A number of means, also, have been tried to cool the gases as much as possible before entering the condensers, and the best of them is to permit the fumes to pass through a considerable length of flue before entering the condensers, and put up, as it were, a preliminary set of condensers. The last chamber should be considered a reserve; no quicksilver should be caught in this chamber; and when any is so caught it shows carelessness or improper firing.

The chief merit of brick condensers lies in the fact that they are easily constructed, can be readily repaired, and are not acted upon, as iron is, by the sulphuric acid which is formed from the sulphurous-acid gases coming in contact with the condensed steam of the ore and an excess of oxygen. Against them, on the other hand, it may be urged, that they retain a great deal of heat, and that the bricks cannot be so well laid as to entirely prevent the escape of quicksilver.

The following principles, deduced from practice, are applicable to other condensers as well as those of brick: condensers must be kept cool; space is required; surface is required; and, to put the above in another shape, *time* is required. If gases are drawn too rapidly through condensers, a large portion of the quicksilver will escape through the chimney. Therefore, the draught must not be too powerful.

Intermittent furnaces are passing out of use, owing to the costliness of their construction, and to the fact that all their merits can be obtained in a simpler form with a perpetual furnace. It would be folly to ignore the advantages of the modern system of working quicksilver. With the new system even small deposits can be worked to advantage; and the money which has heretofore been expended upon the furnaces, can be more advisably employed in developing the works, so that quicksilver-mining need not involve extraordinary risks.

Perpetual or continuous-working furnaces.—In all intermittent furnaces, such as are described above, there is an enormous waste of fuel, since the furnace must cool each time it is discharged, and the quantity of fuel expended in raising the contents of the charge, as well as its thick side-walls, to the proper degree of temperature, has to be repeated each time a charge is burned.

In order to effect a saving in fuel, and because, moreover, the driving off of quicksilver-fumes from cinnabar is simply a roasting process, an attempt was made to work the ores in a perpetual furnace, such as are employed for roasting iron-ore or lime. The first of this kind that was introduced was the Hähner furnace, using charcoal as fuel. The same development from intermittent to perpetual furnaces has taken place in in California, but here the furnaces burn wood as fuel.

Prior, however, to the introduction of the Hähner or other similar furnaces, a continuous-working reverberatory furnace had long been in successful operation at Idria. This furnace is used to work up the small pieces of ore and the slimes and other products of the concentrating-works. Its use led to the introduction of iron tubes as condensers; and the facts learned from their use are of great value in determining upon any given system.

In describing the various perpetual furnaces, I shall first take up this last-mentioned reverberatory or "Alberti" furnace, and afterward the Hähner furnace, as a type of those shaft-furnaces which use charcoal as fuel; after which the three kinds of perpetual furnaces used in California will be brought forward as types of wood-burning furnaces.

The Alberti (reverberatory) furnace.—The details of working ore in this furnace are described in all of the recent books on metallurgy. Here I confine myself to a bare outline, in order merely to show the cause which produces certain effects.

This reverberatory furnace, as has been said, is used at Idria to work up the small pieces of ore and the proceeds from the concentrating-works. The average assay value of the stuff thus worked is only about 1.55 per cent.

When first put into operation the furnace is charged with 4,500 pounds of ore, spread over the bottom. When this is sufficiently burned, the front third of this quantity, say 1,500 pounds, is raked forward and dropped through an opening in the hearth, back of the bridge-wall, where it remains until room must be made for another lot, when it is removed by means of a side door.

The remaining two-thirds of the original charge are then turned over and raked forward, and thus sufficient space is left at the back end of the furnace (where the heat is not so great as it is nearer the bridge-wall) for a new charge weighing 1,500 pounds. In this manner 4,500 pounds are kept constantly in the furnace, and at intervals of three hours one-third of this amount is discharged, and about 1,500 pounds of fresh ore are added.

Each furnace is capable of working up 6 tons per twenty-four hours. Each charge remains nine hours on the hearth, subject to the heat from the fire-place, and three hours longer in the opening spoken of, during which time it throws off what quicksilver still remains in the ore.

The work is carried on in shifts of eight hours each, and sixty-two men are required for eight furnaces, which in twenty-four hours will work up 48 tons. A campaign lasts six months; but the men are changed frequently, as the escape of some fumes can scarcely be prevented, and the work is therefore very unhealthy. There is, moreover, some escape of quicksilver through the brick-work; but, nevertheless, about 70 per cent. of the assay value of the ore is extracted.

This high yield is chiefly due to the system of condensation employed. The fumes, after leaving the furnace, pass into a brick chamber at the end of the chimney, thence into two long tubes of cast iron, 3 feet in diameter, and say 40 to 50 feet long; and thence into a series of brick chambers, from which they finally emerge into another tube of cast iron which conducts the gases back to the chimney. This latter is also divided up into a series of compartments.

The iron tubes are kept cool by water dripping upon them constantly. A number of instructive facts have been taught in the working of these condensers, which are the more entitled to respect as the results obtained are from years of experience.

In the first place, concerning the relative proportion of the yield of quicksilver in the various compartments of the condensers; calling the average assay-value of the ore 1½ per cent., or, say, 30 pounds of quicksilver in a ton (of 2,000 pounds) of ore, and assuming that the actual yield is about 70 per cent. of this, or, in round numbers, 20 pounds of quicksilver to the ton, then 1,000 tons of ore would yield 20,000 pounds of quicksilver, and it has been found that of this amount of 20,000 pounds there must be caught—

	Per cent.	Pounds.
In the first brick chamber	0.6 or	120
In the lower tubes, and lower story, second chambers	95.1 or	19,020
In the upper tubes, and upper story, second chambers	2.8 or	560
In the compartments of the chimney	1.5 or	300
		20,000

In the first brick chamber, as is seen, only a very small portion of quicksilver is caught. This is due to the fact that the gases enter this chamber at a high temperature, and pass out of it rapidly to the cooler space beyond. Besides, as the working of the furnace is continual, this chamber becomes more and more heated. However, though but little quicksilver is caught, the chamber is of use in diminishing the tension of the vapors.

As soon as the vapors enter the iron tubes, which are cooled by the application of water, the deposition of quicksilver is very rapid. This is because the condensers are kept cold; and as iron radiates the heat received from the gases very much better than brick, it shows a superiority of the former over the latter, in this respect at least. There are, however, serious drawbacks to the use of iron. In the first place, it is costly. Secondly, the sulphuric acid which is formed will destroy the bottoms of the tubes in the course of time. As long as they last, however, they are decidedly superior to the brick condensers in use. Again, in examining the returns it will be seen that 95 per cent. of the total yield is caught in the lower tubes and the chamber into which the lower tubes discharge; but of the quicksilver that still remains to be caught (say 4.3 per cent. of the total amount) only 28 per cent. is caught in the upper iron tube and its accompanying upper story of the second brick chamber. This shows that notwithstanding the greater coolness of the upper tube of iron, a portion of the quicksilver present (and it must by this time be in a finely divided metallic state,) is carried on in the current of gases, and proves the necessity of breaking this current of the gases, or in other words exposing surface to the fumes, so long as this does not interfere with the necessary draught.

These iron tubes are cleaned out only once in six months, and the brick chambers are swept down once a year. It is found that, in the course of the campaign (six months) a deposition of soot has accumulated in the tubes to a depth of 12 inches, containing 40 to 60 per cent. of quicksilver. This soot after being worked over on an incline floor (in the manner already described) to rid it of all the metal possible, is reburned in a retort. The amount of soot deposited depends upon the nature of the fuel used, and the more or less bituminous nature of the ore.

The result of various experiments showed that the diameter of the tubes should not exceed 36 to 40 inches, and furthermore that it is better to cool the tubes by a constant dripping of water, rather than by submerging them in a body of water. The reason of the former is that the coolness of the water abstracts heat from the gases but a short distance within the tubes; so that if the diameter is too great there will be, so to speak, an interior channel of hot gases. The reason for the latter rule is, that if tubes are submerged in water, there must be a large quantity of the latter which soon becomes heated to the same temperature as the tubes, and which, under ordinary circumstances, cannot be replaced by a fresh supply with sufficient rapidity to effect a diminution of the temperature. Besides, if the tubes were not exposed a flaw in them could not be seen.

To sum up all experience on the subject, it may be said that the advantage of using iron for condensers is, that by the application of water, or even without it, they can be kept cool, and the condensation of the quicksilver can be effected as thoroughly as possible. On the other hand, the objection to the use of iron is its cost and its liability to destruction by the sulphuric acid that is formed. If sheet-iron instead of cast iron were used, the cost of constructing condensers would be very materially reduced, and these could be kept cool with a less amount of water. At the same time it is evident, that, being of less thickness, these sheet-iron condensers would be acted upon much more rapidly than cast iron by the sulphuric acid that is formed. It has been observed, however, that the sulphuric acid attacks chiefly the bottoms only of the condensers; and on this account it seems to me that the best condenser that can be used, on account of both cheapness and effectiveness, would be one with a wooden or a cement-covered brick bottom with the sides and top of sheet-iron. This kind of condenser is especially adapted for new deposits, the value and extent of which being unknown, makes it desirable to avoid all unnecessary expense in development.

The Hähner furnace.—The success that attended the introduction of the Alberti furnace in the working of small-sized ore, and the desire to economize in fuel, as well as in the expense of preparation, led to the introduction of the Hähner furnace as a perpetual furnace for the burning of the large-sized pieces of ore. This was a combination of an old-fashioned iron-ore-roasting furnace, into which the ore and fuel (charcoal) were charged in alternating layers, with the brick condensing chambers of the Idria furnace. It was endeavored to effect a greater coolness in these condensing chambers by making the top of iron instead of brick, and by turning on a stream of water to keep this iron cool. But the condensing-chambers became gradually so heated from the steady stream of hot gases, that the percentage of quicksilver extracted fell to about 60 per cent. of the assay value. Notwithstanding this falling off in yield, the success of the system was considered as demonstrated, since it effected a great saving in the cost of fuel and in the cost of preparing the ore for the furnace. Soon after the introduction of this Hähner furnace, the proprietors of the quicksilver mine at Vall' Alta, in Modena, introduced a combination of this plan with the iron tubes of the Alberti furnace, for which a decided success has been claimed.

It is not necessary to go into the details of the result obtained from the Hähner system with brick condensers, as all the essential features will be shown in describing the combination furnance, but before giving a description of the combination furnace, or of the other styles of continuous-working furnaces, I wish here, as a matter of interest, to give a table showing the results of working the ore at Idria, in the various kinds of furnaces that (as far as my knowledge extends) have been tried. I do not take the trouble to reduce all the weights and values into English equivalents, as these will always differ with different circumstances, and my object is merely to show the relative results.

Statement showing working results of the furnaces of Idria in 1852.

[Compiled from M. E. Huyot, Annales des Mines, T. 5, s. 5, 1854.]

Furnace.	Contents of quicksilver, 100 kilograms of ore.	Amount of quicksilver extracted from foregoing.	Loss.	Percentage extracted.	Percentage lost.	Cost of working 100 kilograms of ore.	Cost of producing 1 kilogram of quicksilver.
	Kilos.	*Kilos.*	*Kilos.*			*Francs.*	*Francs.*
Leopoldi (intermittent)	3.26	2.36	0.90	73	27	1.30	0.54
Perpetual:							
Alberti	1.23	1.10	0.23	71	29	0.98	0.88
Pult	1.098	0.532	0.566	48	52	0.98	1.84
Hähner	3.11	1.90	1.21	62	38	0.96	0.50
Average	1.85	1.30	0.55	70	30	1.0379	0.7923

The Leopoldi furnace yields the highest percentage, but the cost of producing a given amount of quicksilver is nearly 33 per cent. greater than the others.

The Alberti furnace reduces only the fine dirt, and though the percentage of yield is slightly less than that obtained in the Leopoldi, the cost of working is very much less, notwithstanding that the grade of ore is much lower.

The Pult furnace gives the results of an experiment to use a number of small tubes (say 15 inches in diameter) instead of the large tubes of the Alberti furnace. The cost of working the ore was the same; but the yield was very poor. The cause of this was the imperfect draught.

The Hähner furnace, reducing ordinary ores, produced quicksilver at a much less cost than the Leopoldi; but the condensation (in brick chambers) was imperfect, owing to the constantly increasing temperature.

That the perpetual furnaces effect a great saving in the cost of working the ore is very manifest in the above table. It is also seen that the percentage extracted by using the iron tubes of the Alberti furnace is much greater than the percentage obtained from the brick chambers of the Hähner furnace. It is this fact that led to the introduction of the combination furnace yet to be described.

I also give a synopsis of the total work done in 1852 at Idria, with cost and profits:

	Kilograms.
Total quantity of ore treated	17,411,210.42
Quicksilver contained to the assay	322,060.36
Production:	
Direct distillation	140,263.16
From the murcurial soot	84,403.00
	224,666.16

		Francs.
Selling-price of 1 kilogram of quicksilver		8. 8992
Cost of packing per kilogram of quicksilver, francs	0. 2035	
Cost of mining per kilogram of quicksilver, francs	1. 9734	
Cost of burning per kilogram of quicksilver, francs	0. 7923	
		2. 9692
Profit on each kilogram		5. 9300

or, to reduce the above to American weights and values, we have

	Cost per ton of ore, (2,000 pounds.)	Cost per pound of quicksilver, in cents.
Packing	$0. 4707	1. 846
Mining	4. 5507	17. 892
Burning	1. 9970	7. 196
	7. 0184	26. 934
Selling-price per pound		80. 734
Balance, being profit per pound		53. 8

It will be seen from the above that the cost of burning is less than one-third of the total cost; but the relative proportion of the cost of different departments of the work will differ greatly with circumstances.

In the published reports of the New Almaden mine, California, the items of cost are not detailed; but the following figures may be of interest for the purpose of comparing the results with those obtained at Idria.

Amount of ore treated in fourteen months, say from September 1, 1863, *to December* 31, 1864.

		Tons.		Pounds.
Ore	Gruesos	657 $\frac{200}{2000}$	yielding	3, 446, 020
	Granzas	10, 163		
	Tierras	2, 002 $\frac{1800}{2000}$	yielding	120, 180
Total		12, 823	yielding	3, 566, 200

The average yield of the ore was 15.42 per cent.

The average yield of the tierras is estimated at 3 per cent.

Cost of mining and burning	$645, 046 94
Cost of improvements	62, 086 97
Cost of prospecting	175, 000 00

The cost of production, exclusive of improvements or prospecting, was $59.61 per ton, or, per flask of 76½ pounds of quicksilver, $14.45.

In 1865, the amount of ore worked was	15, 974 tons.
Of which the Tierras amounted to	1, 955 tons.
The ore yielded 12.43 per cent., or say	45, 545 flasks.
Tierras yielded (estimated) 3 per cent., or say	1, 533 flasks.
The actual cost of mining and burning the ore amounted, per ton of ore, to	$53 17
And, per flask of quicksilver	15 49

Comparing the two statements it will be seen that in the first case, cost per ton was $59.61, and per flask $14.45; in the second case, cost per ton was $53.49, and per flask $15.49.

In order to compare the above statements, I place the results in the form of a table:

Time.	Amount treated, in tons.		Percentage extracted.		Cost of treatment.	
	Ore.	Tierras.	Ore.	Tierras.	Per ton.	Per flask.
				Per cent.		
Fourteen months to 1865....	10,620	2,003	15.42	*3	50.61	$14 45
Twelve months to 1866......	14,019	1,935	12.43	*3	53.17	15 49

* Estimated.

It will be seen that in the second statement a larger amount of ore was worked in a given time, and consequently that the cost per ton is less than in the first case. But the quality of the ore was inferior and the yield per ton was less; consequently the cost of producing a flask of quicksilver was greater.

As a rule, when rich ore is found it occurs in masses of considerable size, so that the mining-cost per ton is very much reduced. While the cost of burning per ton remains the same, or is slightly greater, the greater yield of quicksilver reduces the cost of the metal.

As the cost of the metal produced varies, therefore, with the percentage of the ore, it is almost impossible to deduce from the experience obtained at one mine what may be expected at another.

The classification of the ore in the first statement may require explanation.

Grueso is the term applied to the large pieces of ore.

Granzas are small-sized pieces of ore.

Tierras refer to the fine dirt impregnated with cinnabar, and which must be made into adobes (sun-dried bricks) before burning.

Most ores occur as granzas. The proportion of tierras, or fine dirt, to the total amount of stuff worked is about 7 per cent. The contents of these tierras may vary from 1 to 15 per cent., but at Almaden they are estimated to yield, on an average, about 3 per cent. metal.

If these tierras were charged without preparation into the furnace they would form such a compact mass that it would be impossible to burn the charge thoroughly; consequently they are made into bricks by slightly moistening the earth and molding the mass into proper forms.

To return now to the question of perpetual-working shaft-furnaces. These, as I have said, may be of various shapes and sizes. The thorough roasting of the ore is easily accomplished as long as a good draught can be maintained, and, therefore, attention must be chiefly directed to diminishing the cost of labor and fuel. It is also necessary to simplify the routine of work as much as possible, so that no loss may attend the carelessness of the workmen.

The combination furnace of Vall' Alta.—The roasting-compartment of this furnace differs from the original Hähner furnace in that it has condensing-chambers next to the shaft, through which the gases must pass before they enter the iron tubes which form the main features of the condensing system.

The gases are cooled to a slight extent only in these chambers, so that here the deposition of quicksilver is very small. But in the iron tubes the condensation takes place rapidly. In fact, the results obtained are very similar to those already described in speaking of the Alberti furnace, in which it was seen that the lowest tubes condensed nearly all the quicksilver, and that only a slight proportion of the total yield was gathered in the upper tubes and in the chimney-compartments.

The fuel in use is charcoal. In the original Häbner furnace the charcoal and the ore were charged in alternate layers; but at Vall' Alta the two are intermixed beforehand and are charged together. The furnace is cylindrical in shape, about 18 feet high, and 4 feet in diameter. The ore and fuel rest upon a grate formed of movable bars of iron.

The furnace, under full headway, is filled to a height only of 12 feet, which space is occupied by six charges. A charge is withdrawn and a new one is added every one and a quarter hours; so that each charge remains seven hours in the furnace. Before it is dropped into the furnace, however, the charge is somewhat warmed by having been placed in a hopper at the top of the furnace as soon as the previous charge is made.

But I will describe the operation in greater detail.

As soon as the ore and charcoal composing a charge fall into the furnace, they come into contact with the burning ore. They become rapidly heated; the water present is driven off as steam, and soon the fresh charcoal takes fire. Then commences the distillation of the quicksilver, and the ore becomes red hot. After about one and a quarter hours a fresh charge of ore and fuel is dropped into the furnace. The temperature immediately falls, owing to the fresh material and the amount of cold air which enters with it; but the lost heat is soon regained, and the new charge begins to burn freely. It is during this period that the first charge throws off most of its contents in quicksilver. It becomes successively the third, the fourth, the fifth, and so on, during which time all of its accompanying charcoal is burned up, and the mass becomes cooler and cooler, until it is finally discharged quite cold.

It will be seen from the above description that the greatest heat of the furnace is necessary near the top of the mass of ore, and that the object in filling the furnace to a height of 12 feet is to give the ore ample time to distill off all the quicksilver before it is discharged. To fill the furnace to a greater height than this would be liable to render the lower portion too compact to allow free passage of air through the grates. A certain quantity of fresh air is always necessary to effect a thorough combustion of the charcoal, and to convert the sulphur into sulphurous-acid gas. The space above the charge is necessary to afford sufficient time for the air to work upon the burning sulphur, and to prevent the fumes of quicksilver from passing off under too great a tension.

The necessary quantity of charcoal varies from 3 to 5 per cent. of the weight of the ore, and depends upon the nature of the latter. At Vall' Alta a charge of ore weighs about 2,000 pounds, and this is intermixed with about 60 pounds of charcoal.

Mixing the ore with the fuel has the great advantage of preventing the mass from becoming too compact during the distillation of the quicksilver. Moreover, the heat from this fuel is more thoroughly utilized than the heat from a wood fire, not only because of the manner in which it is used, but also because all woods contain a notable percentage of water, which necessarily causes a loss of heat in being converted into steam. The presence of steam is not injurious to the roasting of the ore. It helps to carry off the fumes of quicksilver, but its presence in the condensers is not desirable. In Europe comparative tests have always decided that it is cheaper to use charcoal rather than wood as fuel. A disadvantage in this method of roasting the ore is that the temperature cannot be as easily regulated as in wood-furnaces. Moreover, a certain extra amount of labor is required to mix the ore and charcoal together.

It will be understood from what has been previously said that, instead of the furnace in use, one of simpler construction might be adopted. Also, instead of the expensive iron tubes, any other system of condensation could be introduced.

A campaign generally lasts a year, supposing no accident to happen in the mean time; and then the furnace is gradually "fired down," the condensers are cleaned of accumulated soot, and all necessary repairs are made to the brick-work, &c.

Generally speaking, two or three furnaces are built together; each, however, having its separate condensers. As a charge consists of, say, 1 ton, and as a charge is made every one and a quarter hours, it follows that these two furnaces will work up about 38 tons in the twenty-four hours.

To attend to these furnaces fifteen men are required, say five men on each shift of eight hours. Of these five men, two are engaged in charging, two in discharging, and one in wheeling away the burnt ore and in helping the others.

Perpetual furnaces of California.—In California there are no furnaces in which charcoal is burned as fuel. A Hähner furnace, or modification thereof, was introduced about ten years ago; but as the deposit of ore which supplied it contained but very little cinnabar and was soon exhausted, the works were abandoned soon after the furnace was built.

All the California perpetual furnaces burn wood as fuel, and this has one definite advantage over the use of charcoal in that the temperature of the furnace can be more easily regulated; also, the gases leave the furnace at a comparatively low temperature.

But the essential feature of the California system is the use of a suction-fan wherewith to increase or diminish the draught, and to cause the effectual passage of the gases and fumes through even a compact mass of ore. This does away with the necessity of chimneys of great height, and counteracts all the irregularities which attend a natural draught. Besides, it hastens the roasting process by removing the gases as fast as they are formed, and creating almost a vacuum above the charge. As the draught can be made very powerful by merely increasing the spread of the fan, it is possible to charge into the furnace even small pieces of ore. The proportion of small ore to large pieces being very large (as will be seen from various preceding statements) the importance of this advantage will be readily admitted. The very fine dirt will be more advantageously made into adobes, and these adobes should not be over 4 to 6 pounds in weight.

As ore of all sizes and all grades can be burned in these furnaces, a very great saving is effected by doing away with all expensive assorting or concentration, and therein lies another great advantage of these furnaces.

Furthermore, the cost of furnaces for this system for the amount of ore roasted is trifling as compared with the cost of an intermittent furnace of the types in use; and the size and thereby the expense of a furnace can be governed entirely by the productive capacity of a deposit.

Finally, the roasting of the ore is as thoroughly performed with these furnaces as it can be done with an intermittent furnace.

Although the advantages of these furnaces are agreed to without dissent among California quicksilver-miners, the best shape for a furnace is yet a matter of question, and one which will be developed but slowly, as there are not many deposits, and it is natural for all miners to prefer that which has been tried to any innovations of unproved advantage.

The owners of the Redington mine contemplate abandoning their large and extensive works, and intend to erect perpetual furnaces capable of reducing some 30 to 40 tons daily of ore averaging 1 to 1½ per cent. Hitherto this ore had to be assorted up to 5 per cent. in grade. The other large mines will also adopt these furnaces in the course of time; but none have decided upon the style, nor, in fact, are they aware of the number of styles in use.

The perpetual furnaces now in operation are Riotté's sublimator, Knox & Osborne's furnace, and Pershbacker's. The principle involved is the same in each furnace, but they differ in the form of the shaft and in the method of heating, though each uses wood as fuel.

Riotté's sublimator.—This is almost an exact copy of a Swedish iron-roasting furnace. The shaft is nearly cylindrical, but with a varying diameter, being about 3 feet wide at the top and about 5 feet wide near the middle and at the bottom. The inner lining is made of one course of fire-brick; the outer wall is of common brick, 16 to 20 inches thick, and the two are separated by a hollow space, whereby the walls are allowed room for expansion and contraction, and the outer wall is thus kept cooler.

As in the iron-furnaces mentioned, the fire-place is built within the shaft, and is covered over with plates of iron to protect it from the ore above. The ore in descending passes on either side of this fire-place, and is discharged through two doors, one on each side. The ore is charged through a hopper on top. The draught is provided by means of a suction-fan. There are two of the furnaces in use at the Oakville mine.

The Knox furnace.—This is much larger and much more massive than the above. The upper portion of the shaft is circular, but it soon begins to widen out, and opposite the fire-place near the middle of the height of the shaft it is rectangular with curved ends. Below the fire-place the sides of this rectangle begin to contract to the discharge-opening. The fire-place is built in the masonry on one side of the furnace, and the products of combustion, &c., pass through a series of arched openings into the mass of ore. Opposite the fire-place are other arched openings through which the gases and fumes from the burning ore are drawn into the condensers by means of a draught created by a suction-fan.

The interior lining of this furnace is of fire-brick. This is inclosed in heavy masonry, now made 7 feet thick. The whole is tightly braced by stringers of wood on the outside. A heavy cast-iron plate covers the bottom of the discharge-opening, and the lintel is also of cast-iron. These protect the masonry from excessive wear incident to the discharge of so much rock. A current of air from the outside passes through a flue which encircles the lower part of the furnace and finally enters the fire-place.

The distance across the furnace from fire-place to exhaust-openings is 9½ feet, so that the flame and heat must pass through this width of ore, which is rendered the more compact by the superincumbent weight of a larger mass of ore. This furnace is in use at the Manhattan and at the Phœnix mines.

Objections to the Riotté furnaces.—The objections to these furnaces are as follows:

The fire-place in the Riotté furnace is, as I have said, placed within the furnace and near the bottom of the shaft. This method of heating a furnace is doubtless (since it is in common use) very applicable to the roasting of iron ore, which is generally fed in large pieces, and where the fumes and gases have an unimpeded exit, but the objections to its use in a quicksilver furnace are three-fold:

1st. The quicksilver ore, for proper burning, should not be in size over 4 or 5 inches in diameter, and varies from that to small sized pieces. Therefore, the mass of ore which constitues a furnace-charge is always tolerably compact, and is especially so as it approaches the bottom of the furnace. It is visibly compact opposite the fire-place in the Riotté furnace.

From the above it will be seen that there is a limit to the height of the charge.

2d. In charging a furnace it will be found that the coarse ore settles near the sides and the fine ore near the center of the shaft. At any rate, the mass of ore presents some portion which is less compact than other portions; and the draught is necessarily stronger through the loose ore than through the fine ore. From this cause the heat and flames from the fire-place of the Riotté furnace may at times be drawn through the openings on one side of the fire-place, and thereby prevent the ore on the opposite side from being thoroughly roasted.

From the above it will be seen that there is a limit to the *width* or *diameter* of the shaft.

3d. I do not think the use of hollow walls can be recommended, however advisable they may prove when other than quicksilver ores are roasted. No method of construction known is absolutely proof against the occurrence of cracks, or minute fissures, in a roasting-furnace; and this fact, which for other ores is of no consequence, is a disaster in working cinnabar, since the metallic fumes are sure to work their way out and be lost; and as these cracks widen in the course of time, the loss will be increased.

Although by using a suction-fan these evils, in part common to all furnaces, are rendered less decidedly detrimental than they would otherwise be, yet it is certainly desirable to have a furnace as nearly perfect as possible.

Riotté's furnace commends itself by its cheapness of construction, and the ease with which it can be repaired.

Objections to the Knox furnace.—The objections to the Knox furnace are as follows:

1st. The weakness of the walls of the shaft, caused by a portion of the height being formed by a series of arches (4 to 6, in practice) which leave openings on the one side for the passage of the products of the combustion of the fuel, and on the other for the exit of the gases and fumes. This objection is fully sustained by the recent falling in of these arches at both of the mines where the furnace is in use.

2d. The arrangement of the fire-place, which permits too much fuel to be wasted in heating up the outer masonry.

3d. The heavy masonry on the outside and the further bringing together of the furnace by wooden ties—all of which in this furnace is rendered necessary by the present construction of the fire-place, which is thus not only defective in itself, but also the cause of an extreme costliness in the construction of the furnace.

4th. The form of the furnace involves too much cast-iron to protect the bottom of the shaft against wear and tear. The lintel-piece alone weighs about 3,000 pounds, and the iron on the bottom weighs upwards of 5,000 pounds.

5th. Finally and chiefly, (as the cost of fuel and expense of construction are secondary to the effectiveness of work,) objection must be made to the great width of the furnace between the fire-place and the place of exit for the fumes, &c. This is 9½ feet.

It follows that the ore nearest to the fire-place must be excessively hot in order to create anything like a high heat on the opposite side of the furnace. If the heat on this opposite side is high, then all the ore may be thoroughly roasted; but it is evident that there is a likelihood of the ore on one side of the furnace being thoroughly roasted, while that on the other side is only partially so. At all events, there is necessarily a great difference of temperature on the two sides of the furnace, and when the ore worked is liable to agglomerate under intense heat, the defectiveness of this system is at once apparent.

There is, however, one feature of this furnace deserving of commendation, and that is that each succeeding arch is set farther back than the preceding, and thereby the ore does not crowd into and fill up the openings left for the passage of the flames. This is a trouble which is often experienced when the fire-place is separated from the ore compartment by pigeon-hole walls.

That the objections which I have stated are not in practice so observable in all respects as they would otherwise be, is owing to the advantages derived from the use of the suction-fan. And moreover, as I may remark here, neither of the introducers of the furnaces described would admit of the justness of my objections, although each condemns the system of the other.

The Pershbacker furnace.—Instead of giving a description of the Pershbacker furnace, I give that of one which resembles it, but in which the various objections above mentioned are obviated as far as possible.

In this furnace I have endeavored to combine cheapness and durability with effectiveness of work.

The shaft of the furnace is 5 feet square, but the corners are rounded to prevent the mass of ore from being here more porous than elsewhere. The diameter of the furnace is adapted to ores of ordinary size; but if ore of smaller size is produced in abundance, perhaps a 4-foot furnace would be better.

From the top of the fire-bridge to the top of the furnace-charge is 9 feet, but this again can be regulated to suit the nature of the ore. The object to be attained is that the superincumbent mass may not render the ore too compact for the passage of heat, &c. An open space is left above the ore in order that the gases and fumes may not leave the furnace under too great tension, and thereby carry over particles of fine dirt into the condensers.

Two fire-places are used, so that the ore on each side of the furnace may become thoroughly heated. The fire-bridges are set back so that the ore may not accumulate thereon, and furthermore, by the sudden widening of the furnace at this point, that the ore in descending may become less compact when subjected to the greatest heat.

Below the fire-bridge the furnace is contracted toward the discharge-opening, so that the cast-iron at the bottom need not weigh heavily. At the same time ample room is given so that the burnt ores may remain in the furnace several hours, and may during this time throw off the fumes of quicksilver of which they were not thoroughly deprived.

The shaft of the furnace is constructed as follows: The interior lining is of one course of fire-brick, laid in clay or mortar. This is surrounded by a casing of sheet-iron, but between the iron and the bricks is a space of 6 inches filled with sand or wood-ashes. This intermediate lining of sand or wood-ashes allows amply for all contraction and expansion, while the sheet-iron binds the whole together. If cracks or fissures occur, and fumes of quicksilver escape through the fire-brick, they will be caught in this sand lining, which, at the head of a campaign, or at least when the furnace is torn down, should be worked up with the ore.

Cast-iron plates rest on top of that portion of the furnace wherein the fire-places are built, and support the shaft above so that no undue strain comes upon the arches opening above the fire-bridge.

The bottom of the furnace is protected by cast iron. This, as well as all the other plates of cast iron, may be cast in sections if necessary.

The fire-place is so arranged as to allow ample room for the admission of air, not only through the gates, but at the farther end, whereby an adequate supply may be obtained for the thorough combustion of the fuel and for the admission of air into the furnace to effect a thorough burning of the sulphur.

The use of two fire-places does not necessarily involve a greater consumption of fuel. On the contrary, by permitting the thorough combustion of the fuel, the amount used under good management should be less; and furthermore, a thorough combustion of the fuel will prevent an undue accumulation of soot in the condensers.

This furnace, like several others, requires the use of a suction-fan.

Any system of condensers may be used with the above furnaces, whether of wood, brick, or iron.

The Riotté furnace has no particular system in use. It is claimed that the gases leave the furnace in so cold a state that wooden condensers are quite as efficacious as others.

Messrs. Knox & Osborne employ as condensers a series of cast-iron tanks, which we kept cool with water. These tanks are cast in three parts, and are provided with an opening through which the quicksilver runs out as fast as it accumulates, and also with a door which permits of the furnace being opened and cleaned out with ease.

Experience has taught that the wear and tear of the condensers is confined chiefly to the bottoms. These are rapidly destroyed by the sulphuric acid that is formed, so that in order to make the condensers last any length of time these bottoms are now cast 3 inches thick along the middle where the deterioration chiefly takes place. The sides of the furnace are not attacked to any extent, and last a long time.

These condensers appear to work well and to be excellent in every respect except their cost.

Other condensers are built of wood and of sheet-iron. A combination of the two forms a very efficient condenser, and ore which can be cheaply constructed. The inclined bottom is of wood and is covered with cement in such a way as to allow the quicksilver to flow freely to the discharge-opening. This cement when it is worn out can be burnt in the furnace, to save any particles of quicksilver it may contain. Over this bottom is erected a framework of wood, on the top and sides of which are nailed or screwed pieces of sheet-iron. In order to lessen the cost, the size of these condensing tanks might be made to correspond with the ordinary marketable size of sheet-iron, whereby the cost of riveting is done away with.

The various condensers are connected with one another at alternate ends by sheet-iron pipes.

I prefer the use of iron to either brick or wood, because of its better radiating power, and the ease with which it can be kept cool. Although sheet-iron will deteriorate much more rapidly than cast iron, it can be kept cool more easily, is considerably the cheapest, and all the wearing parts may be replaced without much delay. Hence the use of sheet-iron is cheaper in the end and considerably cheaper in the first outlay.

In the very nature of things quicksilver furnaces and condensers are sure to wear out, so that excessive durability must not be expected; therefore there should be no hesitation in the use of sheet-iron which answers so well while it does last. In fact, it is so easy to keep cool, that the use of water is scarcely needed. It should be stated, however, that the nature of some ores might be such as to make the use of sheet-iron inadmissible.

Of the suction-fans employed there are various kinds. Almost any will answer, if it is made of wood. I prefer, however, the more expensive but more effective Root fan used by Knox & Osborne. It is the same used in many mines on this coast as a ventilating blower. As a suction-fan its action is merely reversed.

The pistons of this blower or fan are of wood. The sides, against which these pistons must play as closely as possible, are also wood, and it is better that the staves should be soaked in oil, as they will then wear longer. The staves are bound together by bands of iron. Sheet-iron cannot be used instead of the wooden staves, because some fine dust and sand is apt to be drawn into the blower and will work between the pistons and the sides to the detriment of the latter. The suction-fan draws the fumes, &c., from the last condenser and discharges them through a pipe into another condenser beyond, which may be of wood. With this last condensing chamber, in which soot alone should be caught, a chimney-stack is connected. As the gases by the time they reach this place should be quite cool, this stack may be made of wood. An opening should be left near the bottom, with a cover to it. By removing this cover the temperature of the escaping gases can be ascertained, and any negligence in attending to the condenser will be observable.

The method of working the furnaces is simple and common to all. The ore is brought from the mine to a dump-pile, or, preferably, to ore-bins, near the furnaces. From these the chargers can take the ore in quantities to suit. A trip-wagon, holding one charge, is generally used. But it should be remarked that the ore coming out of the furnace loses weight in burning, and therefore the amount discharged, in weight, at least, must be less than the amount charged, in order to take out as much ore as is put in.

Supposing the furnace to be in operation, it will be seen that in each furnace the amount of ore worked will depend upon the number of times it is charged and discharged. But some kinds of ore must be burned longer than others, and therefore a less quantity can be worked in a given time.

In the furnace I have designed it is intended that there shall be about 9 feet of ore above the fire-bridge, and as the sectional area of the shaft is about 24 square feet, each foot of height should give about one ton of ore of 2,000 pounds; though the weight will vary with the compactness of the mass and the specific gravity of the ore.

Admitting that the furnace-charge weighs 9 tons; then, every hour, one ton of ore is drawn out and the charge in the furnace is lowered by one foot, when a fresh charge is added. Therefore, every ton of ore remains nine hours in the furnace *above* the fire-bridge, and an additional time of three to four hours *below* the fire-bridge. This, as a rule, will give ample time for burning the ore thoroughly; and in this manner from 20 to 24 tons can be passed through daily.

If the ore has a large proportion of fine dirt, or if it is found advisable for any other reason, only 6 feet of ore above the fire-place may constitute a furnace burden. In this case, if six hours of burning is sufficient, the same quantity, say 20 to 24 tons, can be worked daily.

In fact, the furnace is intended to burn fast or slow, and to be charged with such quantities of ore as circumstances may dictate.

These remarks are also applicable to all perpetual furnaces.

It will be found in practice, that near the fire-bridge the heat is intense, and that it is rapidly lessened in height.

The ore when first charged begins to get heated slowly, and throws off vapors of steam. Afterward, as it descends in the furnace it becomes hotter and hotter, until within a few feet of the fire-bridge it begins to glow with a red heat. In the mean time, the sulphur is being converted into sulphurous acid gas, and the quicksilver fumes are escaping. This escape of the gases and fumes is considerably accelerated by the action of the suction-fans. It is evident that the ore must pass gradually from a cold zone into zones of gradually increasing temperature, until it passes the fire-bridge, and then the temperature gradually decreases until the discharge. I think that this system is the only true one, and should thoroughly accomplish the roasting of the ore.

As the ore on top of the charge is cool, and as fresh charges are constantly added, it is evident that the gases and fumes from the roasting ore must lose a great deal of their heat before leaving the furnace. This is as it should be; but it is necessary to exercise care that the temperature should not fall too low, as in this case the quicksilver might be condensed in part before leaving the furnace.

Supposing the furnace is so worked as to put through 20 to 24 tons daily, the amount of fuel required will vary from 1½ to 2½ cords, according to the nature of the ore.

The number of men to be employed will depend on the amount of ore worked and whether a shift is eight hours in length or twelve hours. I do not think that men should work longer than eight hours about a quicksilver furnace, as the air is permeated with fumes. The work, however, is light. Working in twelve-hour shifts, they are required each twenty-four hours, for charging, 2 men, for discharging, 2 men, and foreman attending condenser, &c., 1 man—5 men.

If the suction-fan is run by an engine, then extra men are required to attend to this.

If two furnaces are built together, they will require the extra services of one man who can assist in bringing in wood and in wheeling away the discharged stuff, &c.

The condenser should, be cleaned of its soot as frequently as necessary, which can be done very rapidly. The channel for the quicksilver should be kept clean of soot, by inserting occasionally an iron rod through the discharge-pipe.

General remarks.—It is a matter of importance when different classes of ore are produced from the same deposit that each kind of ore should be treated apart. For instance, it is not advisable to charge the same furnace at times with rich ore and at other times with poor ore.

It is much better that the ore should be so intermixed as to produce as nearly as possible an uniform average of the whole lot; and when it cannot be done without too much expense, it is better to have a distinct furnace for each kind of ore.

The duration of burning the ore and the quantity of fuel employed depend upon the percentage and quality of the ore; but workmen are apt to observe merely a routine in their practice, and they are therefore likely to treat all ores in the same manner.

Constancy of temperature must be observed; for a given amount of fuel burnt at a high temperature will not give the same results when burned for a longer period at a lower temperature.

Care must be exercised that the proper amount of fuel is added at proper intervals; that the heat is never so great as to vitrify the mass; that no ore is withdrawn from the furnace until thoroughly burned; that the draught is regular and sufficient; that the furnace is never overcharged; and that the whole work goes on with system.

The condenser also must be watched closely, to detect any flaw, and all facilities must be kept ready for immediate repairs. The last condenser should have little or no quicksilver flowing from it; the presence of this metal there shows the necessity of greater condensing-room.

Every precaution must be exercised in starting a furnace. Fires should be kindled and the moisture in the masonry or brick work should be expelled at a gentle heat, so that no cracks or fissures may occur. Also, when the furnace is first charged, it should be filled with burnt ore, on top of which one charge of fresh ore may be placed. As soon as the furnace is brought to a proper condition, the charging and discharging may proceed in a regular manner.

CHAPTER XII.

HINTS ON THE WASHOE PROCESS.

It is my purpose* to give some of the results obtained by an experience of nearly seven years in working ores containing silver and gold, by the method of amalgamation in pans, without roasting, frequently called the Washoe process, and in several mills of which I have had charge, but principally in the Owyhee Mill at Silver City, Idaho, which had twenty 650-pound stamps and sixteen pans. I shall discuss here merely the mechanical details for working ores generally, subdividing the subject as follows: 1. Preparation of ore for the stamps; 2. The crushing in the battery; 3. The settling of sand or pulp in vats or tanks; 4. The treatment in the pans; 5. The results obtained in settlers, agitators, and concentrators; 6. The straining of quicksilver, cleaning of amalgam and retorting; 7. The saving of slimes and their subsequent treatment; 8. The loss of quicksilver.

For descriptions of the various kinds of ore-breakers, stamps, tanks, pans, settlers, &c., I must refer to the various works on these subjects, prominent among which are the reports of the United States Commissioner of Mining Statistics, and the volume on "Mining Industry," the third volume of the United States Geological Survey on the line of the fortieth parallel, through the gold and silver bearing regions of the great West, undertaken under the able guidance of Clarence King, assisted by Mr. James Hague and others. In this discussion it will be assumed that the general arrangement of the quartz-mill is understood; and the question will be treated how to secure, from such a mill, the greatest economy in working, combined with the largest results. This place seems fittest for a single preliminary suggestion, namely, that there should be double floors throughout the mill, so that nothing can sift through and be lost.

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* This chapter was written, at my request, by J. M. Adams, mining engineer, of Silver City, Idaho, whose remarkable success in the management of the Washoe process has been the subject of comment in my former reports. Being satisfied that the excellent results achieved by Mr. Adams were chiefly due to great skill and care in the arrangement of mechanical details, and the constant and minute supervision of operations, I thought a simple statement from him, on some points too often overlooked by American mill-men, would be practically valuable to a large and intelligent class of metallurgical engineers. This paper was prepared with the double purpose of publication in this report and of presentation to the American Institute of Mining Engineers at its February meeting in New York. It is, perhaps, scarcely necessary, after mentioning the circumstances under which it was written, to explain that it does not profess to be a complete and systematic discussion of the Washoe process. It contains no detailed descriptions of machinery, no discussions of chemical reactions, and few explanations of fundamental principles. It is addressed to those who are supposed to understand these things already, and therefore to be able to appreciate the value of suggestions drawn from practice. I therefore have taken the liberty of giving it the above title, by way of disclaiming, in justice to the author, a scientific completeness which he did not attempt to secure. I also allow Mr. Adams to speak in his own person.—R. W. R.

1. PREPARATION OF ORE FOR THE STAMPS.

The more uniform in size the ore is prepared for the stamps, the more evenly can it be fed into the mortars. The ore should be so fine that a single blow of the stamp will be sufficient to shatter thoroughly each piece of ore. If a large piece is fed into the mortar, it may not be broken up until after several blows or drops of the stamp. Besides, a large piece raises the stamp and reduces by so much the fall, thereby taking away part of the effect, and consequently diminishing the production. In preparing ore for the stamps, in my first experience at the Owyhee Mill, I used merely rock-hammers. The stamps were dropping sixty times a minute, and were given 8½-inch average drop, running without re-setting till the average drop was 10 inches. Breaking by hand, on average hard ore, we could not work over 28 tons a day. Then, by breaking very small by hand, we increased our production to 30 tons a day. But afterward, by erecting a Blake's crusher, the production of the same stamps was raised to 33 tons a day; by breaking the ore very fine, we increased it to 37 tons a day on the same ore; and finally, by accelerating the rate of running the battery to 93 and 95 drops a minute, keeping the same height of drop, but using a coarse screen, we were able to increase our production to 45 and 48 tons of ore crushed in twenty-four hours. But in breaking the ore very fine we found that the lowest end of the die, or fixed breaking surface, in the crusher, wore away much faster than the middle or the upper part. True, we could turn the die, and so get wear from the upper part; but the middle part was wasted and lost to us, except as old iron. We overcame this by adding to the pattern of the die a projection on the lowest end, thus increasing the thickness at this place, and in this way we were able to get full wear of the whole die. The most economical method of preparatory crushing would be to have two breakers, one set above the other. The mill having, as every mill should have if practicable, plenty of natural fall—in other words, being built on the side of a steep hill—the first breaker should be placed above, and set so as to crush to a diameter of 2 inches. Of course, a long, flat, and thin piece might go through, but at least one dimension will not be over 2 inches in diameter. The fine, as well as the coarse, ore should pass through this breaker. When the ore is dry let a very small jet of water flow into the mouth of the breaker, to prevent the dust from flying. This dust involves a loss and also injures the machinery. From the first crusher let the ore pass by chutes into the second. This should be set so that the breaking surfaces almost meet at the lower end. From here, chutes should lead to each battery of ten stamps or two mortars. If the ore contains much clay, it may be necessary to separate from the massive pieces the fine ore and clay, and deliver the two latter to the battery-floor without sending them through the rock-breakers, which the clay tends to choke up. The consumption of iron per ton of ore prepared in this way, by double breaking, for the stamps will be about 0.3 of a pound.

2. THE CRUSHING IN THE BATTERY.

Here might come a discussion as to the relative advantages of self-feeding and feeding by hand. Eventually I believe that automatic feeding will be universally adopted, especially for ore broken to a uniformly small size. Even under present circumstances the automatic feed is more economical than to have a man feeding who is careless, lazy, or inexperienced. For a good battery-feeder give me a small, intelligent, active, and wiry man; a tall or stout man cannot stand the jar of the battery constantly and do good work. A tough man can endure feeding twenty stamps for twelve hours. If ten stamps or less are to be supplied with ore, self-feeding is more economical than feeding by hand as performed by ordinary workmen; but if the mill is pressed with work, and the pans are of sufficient capacity to crowd the battery, the self-feeding apparatus is not so good as a man active, faithful, and skillful. Even if he must be paid $5 a day, he will more than earn his wages by the increased production of the whole mill. Low feeding is the best; let iron *almost* wear on iron. The skillful workman will feed low and uniformly, and not by sight, but by the sound of each stamp. Under this system a stem may break occasionally, but it does not take long to put in another. The broken stems can be repaired by cutting off above the break and welding on a piece of a bar of rolled iron, which is subsequently turned off in a lathe. Even if three stems out of twenty are broken every month, the cost of repairing, &c., amounts to little compared with the increased production obtained by low feeding.

The stem almost invariably breaks in one place, namely, where it comes out of the stamp-socket or boss. We avoided this evil partially by boring out the socket and increasing the size of the stem where it enters the socket. The broken surface of the wrought-iron stem shows the iron to be thoroughly crystallized; its fibrous condition having been destroyed by the constant jar.* A bar of round iron should be always on hand with which to repair broken stems.

As regards the weight and speed of the battery, my experience favors light stamps and the utmost speed. The Owyhee Mill battery, 650-pound stamps, with 8½ inches drop, (running to 10 inches before re-setting,) was run at a speed of ninety-three drops a minute, the cams having been cut off so as to have short cams. Such a speed gives no time for the stem to settle in the sand; and as long as bolts are kept tight, nuts secure, and guides snug, no serious breakage need be apprehended. On ordinary ores the consumption of iron per ton, including the old iron thrown away, is about two pounds.

As regards the supply of water for the battery, there should be as much fall as possible from the battery to the tanks, so that the conducting-troughs will keep clear and not choke up; they will then require no excess of water. The supply to the battery must vary according to the clay in the ore. Use as little water as practicable, consistent with keeping the screens perfectly clean. The more clay, the more water needed;

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* This inference is not universally accepted. So far as I know, it has not been thoroughly demonstrated by experimental proof that wrought iron can be crystallized by jarring it for any length of time. The fact that broken pieces show crystalline surfaces does not prove the theory.—R. W. R.

the more clay, the greater necessity for careful low-feeding, in order to avoid the choking up of the mortar. If too much water is used, to remedy the effect of careless folding, an unnecessarily large amount of slimes is carried off out of the mill in the waste-water from the battery and tanks. To avoid loss of slimes, it is well to use a rather coarse screen, say No. 4 punched Russia iron, especially in clayey or slimy ores, so as not to *puddle* or churn the ores in the mortar more than necessary. This is particularly to be looked after when the ore is largely true silver-ore, or the gold very fine. As regards setting the battery, it is, in my judgment, preferable to give the central stamp of the five in each mortar the most drop; those adjacent on each side one-fourth inch less, and the outside ones one-fourth inch less still. But some millmen prefer an even set.

Many persons advocate amalgamation in the battery, in order to catch part of the gold and native silver in ores containing, in addition to these metals, silver sulphuret, chloride, &c., or gold coated with oxide of iron, &c., and, therefore, requiring subsequent reduction and grinding in the pans. But there is a strong objection to amalgamation in the battery. The amalgam thus formed is mostly a gold amalgam, and hence it is worth much more than the ordinary amalgam of a silver mill, and of this the workmen are all aware. It is, therefore, an additional temptation to stealing. The only benefit to be claimed for it is the possible catching of some of the gold otherwise floating away in the water and catching in the slimes. It will be found, however, that this amount of gold is very small. By determining the proportion in weight of battery slimes, that is, the fine, clayey material carried away in the waste-water from the tanks and battery, which has never been in the pans, and by ascertaining the value of the slimes in gold proportional to the value of the ore in gold, it will be found that, as a rule, the entire loss in gold in the slimes is not over 1 per cent. of the entire amount of the gold in the ore.* This is not a very heavy loss, and, besides, most of this gold can be collected in the slime yard, while of the remainder much is so fine that it is doubtful if quicksilver in the battery would catch it. The saving, then, is very small, if there be any, on ordinary ores. But, on the other hand, it is not practicable to use quicksilver without a mechanical loss; and the quicksilver being more or less charged with gold, the loss of such as is not gathered and united involves more or less gold also. Every casting, such as a shoe or die, in the battery is full of flaws and blow-holes. Hard gold amalgam collects in these, and in spite of the most careful picking and breaking, (to say nothing of the occasional carelessness of workmen,) every shoe and die, when used up and thrown away, contains a very considerable amount of gold amalgam. The cracks in the wooden troughs get filled with gold amalgam; the settling vats or tanks have their seams, after a long time, calked with it; and in the slime-yards will be found some of the gold partially amalgamated. Why should we, then, amalgamate in the battery, when we know that, except a very small and doubtful saving from the gold of the slimes, (which seems offset by the mechanical losses above alluded to,) all this gold is saved just as thoroughly in the cast-iron pans? The pulp is not concentrated before entering the pans. If it underwent such a process, of course there would be additional chance of loss of fine gold, an additional argument for amalgamation in battery. It will be perceived that the reasoning just given applies, therefore, to the Washoe process, and not necessarily to gold mills where pans are not used. Yet even then the practice of amalgamation in battery is not universal nor, indeed, the best.

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* Mr. Adams is here speaking of auriferous silver ores, like those of the Owyhee district.—R. W. R.

3. THE SETTLING IN THE VATS OR TANKS.

There should be as many tanks as possible, in order to settle the maximum quantity of slimes inside the mill; and the system should be so arranged that as each tank is emptied of sand, the escape or waste-water can be turned into it. Each tank thus becomes in turn the final one of the series, and receives all the water after settling through all the other tanks. There should never be more than three tanks full of sand; the remainder, even if there are twenty of them, should be used for the settling of the slimes in the water.

Each tankful of sand must be settled or prepared so that the contents can be easily handled with the shovels, and charged into the car for transfer to the pans. In other words, the superfluous water must be removed; and this should be done without allowing the slimes to pass out of the tank, only to be carried by the current through the other tanks, and thus be driven ahead constantly toward the escape. Hence, it is as well not to settle the sand at all till the tank is full of sand. Then let the spout be turned into the next tank, and put in the plugs of the full one, thus cutting off communication and isolating this tank, after which the sand may be settled with crowbar and shovel, and the water baled out.

The ore is now in the shape of a wet, coarse sand, called pulp, containing, according to its original nature and the character of the crushing, more or less slime, (locally called "slum.") So far the process has been entirely mechanical, and the efficiency which has been achieved in this part of the treatment is measured by mechanical tests. The result with the arrangements above described may be summarized as follows: 48 tons of hard ore, crushed with twenty stamps of 650 pounds, dropping 8½ inches ninety-five times a minute, the ore from the breaker being fine, and No. 4 screen being used. This is, per twenty-four hours, 2$\frac{4}{10}$ tons per stamp, or 1.39 tons per horse-power developed.

4. THE TREATMENT OF THE PULP IN THE PANS.

There are many different styles of pans. I prefer the Wheeler for a small pan, and the Stevenson mold-board pan where a large one is desired. The general principle is the same. The ore is to be heated and ground thoroughly to an impalpable substance, an active motion or circulation given to the pulp; the silver thoroughly reduced; the gold thoroughly brightened and cleaned from its occasional intimate mechanical mixture with foreign minerals; and finally, the gold and silver are to be as entirely as possible taken up by the quicksilver. Chemicals are used, partly to reduce the ore, partly to save quicksilver and keep it clean, and partly to reduce by cheaper means what would otherwise be reduced at the expense of the quicksilver.

When each charge is drawn, it is well to wash out the pan with water, so as to get all the quicksilver possible out of the pan. There will still remain from 30 to 60 pounds in a flat-bottomed pan (though this form is on other accounts to be preferred) under and around the dies or the lower grinding surface; and there will be, also, more or less amalgam sticking in various places on the sides of the pan, the muller, &c. Charge the pan with the muller raised, and turn live steam directly into the pulp.

This method is preferred because in this way the pan is heated much more rapidly than by a jacket, or double sides and bottom, filled with the exhaust steam; and little work can be done by the pan until the charge is heated. The pulp should be heated almost to boiling. The consistency of the pulp when the quicksilver is put in should be as thick as possible consistently with a good circulation in all parts of the pan; but, inasmuch as the pulp will be ground faster when thin, it is best to have it thin at first. To secure both objects, the pulp may be diluted to such a degree that, after grinding two and a half hours, it will have thickened to the proper consistency for recovering the quicksilver. If this condition is fulfilled, the quicksilver charged into the pan will, after its speedy division into small globules, occasioned by the grinding and the heat, be diffused through the whole mass. A sample of the pulp taken out on a thin wooden spatula should show particles of uniformly disseminated quicksilver. Some of the globules will be microscopic; but from an ounce of the pulp, washed in a horn, a good-sized globule of quicksilver may be collected by rubbing, &c. The pulp, if of proper consistency, will have a good motion, yet be thick enough to carry the quicksilver in suspension just to the surface, as the current rises from under the muller on the outside of the pan. On the other hand, the larger globules of quicksilver will be able to gradually sink through the pulp. Thus the quicksilver describes a course distinctly its own, and a more intimate contact is thereby attained.

If salt is used, it should be introduced as soon as the pan is charged. Sulphate of copper, if used, should be added as soon as the pan is heated up, which ought to take place in fifteen minutes. Then the steam should be shut off and the muller lowered, and grinding commences. The reason for not lowering the muller at the start is to save power, since the pan will grind but poorly, and that with difficulty, in the cold pulp. If the pan has a cover on it, (as all pans should have,) probably there will be no necessity for using the steam again till the charge is drawn and a new one put in, since sufficient heat will probably be retained to render amalgamation effectual.

It may be assumed as a fair average that the charge is run five hours. All the chemicals used, except those for saving quicksilver, are put in the pan at different times, and, after the last one is put in, there should be at least twenty minutes before the quicksilver is charged. I prefer to put in the quicksilver in the middle of the period, *i. e.*, two and a half hours before drawing the charge, and at the rate of 200 pounds quicksilver per 2,000 pounds of ore, or a larger proportion of quicksilver if required by the richness of the ore. Three-quarters of an hour before discharging, the muller is raised, since, if the pan is in good order, the charge should be by this time thoroughly ground, and raising the muller avoids further cutting up of quicksilver by the grinding. At the time of raising the muller, the chemicals used for saving quicksilver may be added. Fifteen minutes before drawing the charge sufficient water is added to thin the pulp thoroughly. This prepares the charge to flow readily out of the pan, and also stirs up any pulp that may be moving sluggishly. At the same time, the mass is considerably cooled.

The range of these remarks being merely mechanical, the subject of chemicals (mainly salt and sulphate of copper) in the pans will not be here discussed. Suffice it to say at present, that my practice and numerous experiments have disposed me strongly in favor of using chemicals, and using them largely. When only a low percentage is expected, and from a docile ore, there is often no need of any chemicals at all, though even then a judicious use of suitable reagents will save some of the quicksilver. The more refractory the ore, the greater necessity for chemicals, and for high heating of the pans. From ordinary and docile ores 80 per cent. of the assay can in some cases be obtained readily, without use of chemicals, by enforcing all the small mechanical details, such as those I have referred to, and by keeping the quicksilver in perfect order. The additional percentage obtained, running up to 95 per cent. and over, which I myself have frequently obtained, on gold and silver ores, is only to be gained by the use of chemicals.

The most important point in the process is to keep the quicksilver always bright, clean, active, and in good order. In working an ore that fouls the quicksilver, if it is not practicable to keep the quicksilver clean in the pan, it should be at least put in perfect order before it is again used for another charge. In such cases it is important to keep the pan as free from quicksilver as possible during the first part of the process. For cleaning quicksilver, sodium amalgam, caustic potash, dilute acids, cyanide of potassium, &c., are used. Even in working docile ores it is well to keep a cleaning-mixture on the quicksilver under the strainers.

The consumption of iron in the pans is about 10 pounds per ton of ore; but this, I think, can be diminished, without loss of efficiency in grinding. From the pan, the charge is drawn into the settler.

5. THE RESULTS OBTAINED IN SETTLERS, AGITATORS, AND CONCENTRATORS.

On drawing the charge, the greater part of the quicksilver runs quickly into the bowl or reservoir of quicksilver in the bottom of the settler, whence it flows out, free from sand, through a siphon, into a kettle outside. It is preferable to fill the settler, when the charge is drawn, with water falling as a rain, and, when the settler is full, to let nothing run out, but turn off the water and run the stirring-arms in the charge for an hour. This collects the floured quicksilver somewhat, and settles it. Then turn on plenty of water, and let the settler discharge through the top plug-hole as long as possible. The operation should be so timed as to reach the bottom hole of each individual settler only just in time to receive the next charge. The settler will never choke with heavy sand if the pan has ground well and the driving-belt is in good shape. In the settler accumulate some coarse sand, some unreduced sulphurets, amalgam, quicksilver, and iron from the pans; and once a week the settler should be cleaned out, and the concentration reworked in the pans.

A good supply of water should be kept constantly running in the agitators. Here there will be found some coarse sand containing a little quicksilver, amalgam, sulphurets, and considerable iron; but the saving is very small. The floors throughout the mill should be kept clean, and the whole mill as neat and free from dirt as possible; no loose quicksilver should be found in the floors, on the tables, or anywhere; all drains should lead into the agitators; and the quicksilver floor, unless the weather be too cold, should be washed with a hose every day.

Except on ores containing a large proportion of heavy sulphurets, or containing much slime that coats quicksilver, I have found but little benefit in concentrators applied to tailings from the pans. In ordinary cases, they collect little except iron from the pans and coarse sand. The pans grind so fine that the precious metal left in the tailings is very difficult to concentrate after leaving the agitators—provided the ore has been well worked. It is necessary to have a regular supply to the concentrator; and this may be effected with siphons of 1½-inch and 2-inch pipe. I have found Hungerford's concentrators very good for slimes and slimy ores, since the shaking collects the floured and slime-coated quicksilver very well.

After leaving the concentrators, the tailings were run, in the Owyhee Mill, over a double set of blanket sluices, 250 feet long; but it was found that on the ores then worked, the saving did not pay for the labor employed in frequent washing; and at last the blankets were worked only about once a week.

6. THE STRAINING OF QUICKSILVER, CLEANING OF AMALGAM, AND RETORTING.

The quicksilver collected in kettles outside the settler is strained through canvas sacks, the amalgam collected is cleaned from small mechanical impurities in a cleaning pan, then re-strained and retorted in an iron retort, beneath which fire is kept up for eight to twelve hours. The distilled quicksilver is condensed by a sleeve, around the escape pipe, filled with water. After cooling, the retort is opened and the bullion is taken out and delivered to the assayer.

The retort is a source of considerable expense in milling. My experience leads me to prefer a cylindrical retort of cast iron, weighing about 1,200 pounds and 14 inches by 48 inches inside dimensions. This style has various external shapes, doors, &c. The main trouble in retorting is this: with a long-continued bright cherry-red heat at the last, almost but not quite all of the quicksilver can be volatilized. The sublimation of the last 1 or 1½ per cent. cannot be effected without heating the retort till part of the bullion is melted, which requires a white heat. At this temperature the iron loses its tenacity, becomes spongy and rotten, and easily changes its shape. In a short time, under this treatment the retort becomes distorted, even if turned around frequently, and after a time it bursts, frequently volatilizing up the chimney 200 pounds of quicksilver. Three or four such experiences a year are rather expensive. I have made many experiments, such as retorting in vacuum, firing twenty-four hours at a moderate heat, &c., but finally concluded to brace the retort as well as possible, never heat it above cherry-red, and submit to the loss of one per cent. of quicksilver for the present. In one's own assay-office I think it can subsequently be saved during melting, by a condensing-chamber in the stack or chimney.

Even at a cherry-red heat, however, the retort gradually gets out of shape, and once out of shape it soon bursts or cracks. To preserve the original shape as long as possible, I found it advantageous to hang the retort on four slings. Each of these is a semicircular cast-iron brace, on which the retort rests. Wrought-iron rods, so attached that they can be renewed if burned out, are fastened to the cast-iron braces, one on each side of each brace. These rods pass through the brick-work, and through flat bars of iron on top, and have, above all, loosely fitting nuts. Of the flat bars on the top of the brick-work, four pass across over the retort on top of the brick-work, and two lie lengthwise, one on each side, and thus the retort is hung on four braces, attached to one common support. If it becomes bulged at all, the sling nearest the distorted place may be raised by means of the nuts, and in the next heat the retort will resume its proper shape. In this way, and by a careful and moderate heat, I was able to make retorts last one and a half years in constant use.

7. THE SAVING OF SLIMES AND SUBSEQUENT TREATMENT.

By slimes or slums I do not mean to include any slimes whatever from the pan-tailings. If the ore has been properly and exhaustively worked, there is not left in any part of the tailings from the pans any gold or silver that can be recovered by working these tailings, unless they be roasted, or exposed to action of air and moisture for many years. The slimes here spoken of have never come in contact with quicksilver and have never been worked at all; they are carried off mechanically by the waste water that leaves the last tank below the battery; and they assay, as a rule, about 60 per cent. as much as the ore. Generally the assay-buttons from the slimes are worth much less per ounce than from the ore, *i. e.*, they contain proportionally less gold. The percentage of slums varies with the amount of clay, and also depends much on the quantity of water used, and the method of settling. In hard ores, with careful settling, the slimes amount to 2 or 3 per cent. of the weight of the ore. The gold in the slimes is very light and flat; the silver occurs largely in refractory sulphurets, and also in a very finely divided state. The slimes from ore worth $16 a ton or upward may be worked with profit. In one's own mill, working one's own ore, it would be economical to raise to a supply-tank above the battery all the water escaping from the tanks, and let it pass again, with the additional water necessary, through the battery. Thus there would be no loss in slimes, as none would leave the mill. But frequently such a change cannot be made in an old mill. In such cases it is necessary to build slime-yards outside the mill. I built my first one in the summer of 1868, after studying a year on the best way to save the slimes; and subsequently I added others, constituting a series, in each of which in succession all the battery-water settled before finally escaping. By means of a bull-wheel, rope, car, and railroad, the slimes were delivered, when they were to be worked, directly to the pans. The richest of the slimes settled in the first yard, since none of them had ever been in contact with quicksilver or worked in any way, and they were kept entirely separate from the pan-tailings. Working these slimes by themselves, it is difficult to obtain over 60 per cent. of the assay-value, even when large amounts of chemicals are used. Moreover, the loss of quicksilver is very large. But by mixing ore and slimes in equal proportions, more "body" can be given to the pulp, and in this way I obtained almost as high a percentage as on ordinary ore, and saved much of the quicksilver that would have been lost. The gain was so decided that, not having a mine, I bought ore to mix with the slimes.

8. THE LOSS OF QUICKSILVER.

Every piece of wood that has come in contact with quicksilver, the canvas straining-sacks, the worn-out pan-shoes and dies, even after careful washing and breaking, the thoroughly washed and shaken quicksilver-flasks, the used-up kettles and dippers, the floors, &c., all have quicksilver sticking to them; the men carry quicksilver on their boots and clothes, and it is found scattered in very small quantities outside of the mill. It goes everywhere. Drop a globule on the floor, you cannot entirely recover it. Climb up 40 or 50 feet to the cross-timbers in the top of the mill, collect some of the dust on top of the timbers, examine it with a glass or wash it, and you will find quicksilver. Some is lost every time crude bullion is melted. Every pound of quicksilver is handled probably forty times a day, and every time there is a little loss. (Quicksilver should be handled as much as possible mechanically, being raised by steam in pipes or some other arrangement.) Quicksilver not covered with water or other liquid evaporates in the air. These losses can only be prevented partially by the greatest cleanliness and care.

Again, quicksilver charged with copper readily becomes coated with small particles of iron. In the pulp, it is readily coated by iron pyrites, grease, slimes, &c., or reduced to great fineness by grinding. In these "floured" and coated conditions much of it will float away and be lost, unless means are employed to collect it. I have found cyanide of potassium very effectual for this purpose. Thorough settling also collects a good deal. Ores containing much talc likewise act unfavorably on quicksilver. As soon as quicksilver is fouled, and becomes sluggish, it not only loses to a large extent its amalgamating power, but also is easily cut up and floured.

In addition to the sources of mechanical loss above mentioned, much of the quicksilver is lost chemically. The water from the settlers, if filtered and concentrated, will show quicksilver present in solution. Sulphate of copper in solution is decomposed by quicksilver, some of the quicksilver becoming sulphate of mercury, while the precipitated copper forms a copper amalgam with the remaining quicksilver. Chloride of silver also can be decomposed by quicksilver, chloride of mercury being formed. If binoxide of manganese is present in the ore, it occasions a heavy loss of quicksilver, also, as I believe, by chemical action. And I might mention other chemical reactions, causing loss of quicksilver. Hence the importance of keeping the pan as clean as possible of quicksilver in the first half of the period of working the charge. The grinding in the first half will not cut up and flour the quicksilver; the chemicals can act on the ore and not on the quicksilver; and the silver-minerals will be reduced by the chemicals, instead of having the expensive quicksilver consumed by reducing some of the minerals or combinations. By observing this simple rule, by using chemicals for saving quicksilver at the end of the charge, and by subsequent careful settling, I have found it possible to diminish very much the loss of quicksilver that would otherwise occur.

In conclusion, I have only to say, that, in my opinion, even base and refractory ores can frequently be worked more profitably by this process than by the vastly more expensive methods of dry crushing, roasting, smelting, &c.

Much of the credit to be given for many points brought forward in this paper is due to Mr. William F. Carter, mechanical engineer, who has worked with me constantly for several years past.

CHAPTER XIII.

SMELTING IN PARK COUNTY, COLORADO.

The following account of the operations of the Mount Lincoln Smelting-Works, at Dudley, Col., was prepared by Edward D. Peters, jr., mining engineer, the manager of the works, to be presented as a professional paper to the American Institute of Mining Engineers. With the author's permission, I introduce it here, in pursuance of the plan explained in my introductory letter, of giving an accurate view of the present state of American practice in the metallurgy of the precious metals, as the only basis for just comparisons and future improvement.

It is not pretended that the small establishment of Mr. Peters, the results of which are here described, constitute a model for imitation in all respects. Several features of the processes employed are susceptible, with the aid of larger plant and capital, of improvement in the direction of economy. I refer particularly to the number of operations and classifications, which is too small for the greatest metallurgical efficiency. Let the reader compare this simple treatment with the complicated manipulations at German works, described in another chapter, and it will be seen that in one case the advantage of greater rapidity and simplicity is dearly purchased with the loss of precious metal and the production of useless waste material. Mr. Peters's main point is his comparison of the blast-furnace and reverberatory for the ores treated. Here his conclusions are both sound and interesting, and are not overthrown by the imperfections of the general process incidental to rough work, on a small scale, in a new country.

It frequently occurs in the establishment of reduction works in an entirely new and untried mining district that the metallurgist in charge finds considerable difficulty in determining the process best adapted to the ores which he receives for treatment.

At the first glance it would seem easy enough to decide what style of furnace is best adapted for beneficiating any one class of minerals. If the ore possessed a quartzose gangue, and was comparatively free from base metals, while salt could be obtained at a reasonable price, one would naturally resort to chlorodizing, roasting, and pan or barrel amalgamation for the extraction of its silver contents. If galena or carbonate of lead was the prevailing mineral, and charcoal could be obtained at moderate figures, the blast-furnace would beneficiate the ores most advantageously. But if, as is usually the case in Colorado, the ores consisted of an intimate mixture of galena, zinc-blende, copper pyrite, and noble silver minerals, associated with an overwhelming mass of siliceous heavy spar or limestone gangue, the common reverberatory furnace can be used to the greatest advantage; and, although the product is only a copper matte, I do not hesitate to affirm that it can be treated, and the silver, gold, and copper produced at nearly the same price for which silver and lead can be separated. In Germany blast-furnaces are frequently used for this same purpose, both for argentiferous and non-argentiferous copper-ores; but any one who will take the trouble to examine the statistics of smelting at Fahlun, the Oberharz, and other continental works of this description, will see that the expenses are far too great and the production much too small to think of employing this method in our mining districts, where only the softest and most miserable kind of charcoal is obtainable.

I propose in this paper to give an accurate account of the expenses incurred at the Mount Lincoln Smelting-Works in treating the same kind of ore, and producing the same end-product in both blast and reverberatory furnaces. I have taken for comparison a favorable campaign of the blast-furnace and a good average month's running of the reverberatory. In the blast-furnace estimate I have included the calcining and concentration of the matte produced during that campaign, as I always, when possible, concentrated the regulus made in each run at the end of the same, without any stopping or repairing of the furnace. It is proper that this expense should be included in the estimate, as it required a concentration of the blast-furnace matte to bring it up to the same value as the reverberatory raw matte.

I will mention that our average matte contained 1,100 ounces silver, 3 ounces gold, and 30 per cent. copper. The following analysis represents the ore that formed our principal supply:

BaO, SO_3	55	per cent.
CaO, CO_2	15	"
SiO_2	20	"
PbS	5	"
ZnS	5	"
Total	100	"

It will be seen that the sulphate of baryta formed the principal constituent of this ore, and, in connection with the iron-ores used for fluxes, formed in the blast-furnace a much larger quantity of matte than was desirable. In the reverberatory, however, the chemical reactions between baryta, pyrite, and silica are entirely different; very much less matte is formed, and the concentration proceeds faster. I have no works to which I can refer for a complete explanation of these reactions, but suggest the following:

$$2BaO, SO_3 + 2SiO_2 + FeS = 2BaO, SiO_2 + FeO, SiO_2 + 3SO_2.$$

One other great advantage that I can point out for the reverberatory is that much less flux suffices than for the blast-furnace, as the slags are raked out through the skimming-door, and can consequently vary very much in their composition without interfering with the progress of smelting. In the blast-furnace, on the contrary, a slight excess of silica will form long noses and perhaps wall accretions, and frequently derange the running of the furnace for twenty-four hours.

But perhaps the most important point of all is that the reverberatory is fitted for using raw fuel. Any smelter who has been forced to burn his charcoal from the spruce and fir of Utah and Colorado will fully appreciate this immense advantage. While the two kinds of wood mentioned produce charcoal that is hardly better than carbonized sawdust, they form in their raw state a most admirable fuel, giving a long and intensely hot flame, and comparing favorably for this purpose with the oak and hickory of the East.

But I will proceed at once to give the promised figures, and allow my hearers to deduce their own conclusions therefrom. The blast-furnace used was 36 inches by 42 inches inside measurement, and 10 feet 6 inches from tuyeres to charge-hole. Six tuyeres were used with 1¼-inch nozzle, and a No. 7 Sturtevant blower supplied the blast. I have reduced all time spoken of to shifts of twelve hours each.

ORE SMELTING IN BLAST-FURNACE.

30 DAYS OR 60 SHIFTS.

Brasque.		
2 loads clay	$6 00	
60 bushels refuse coal	3 00	
Stamping and mixing	21 50	
Total		$30 50
Packing and drying.		
3 men, 2 shifts, (packing)	26 00	
1 man, 3 shifts, (drying)	12 00	
Charcoal brands and wood	7 50	
120 red brick for front and labor	4 40	
Total		49 90
Fuel.		
Filling up furnace, 200 bushels, 48 shifts smelting, averaging 4.5 tons charge per shift, at 56 bushels per ton	12,296	
⅓ extra for waste	4,099	
Bushels coal (at 15 cents)	16,395	2,459 25
Labor.		
1 smelter	5 00	
1 helper	4 00	
1 charger	4 00	
1 coal-roller	3 00	
¼ blacksmith	1 25	
48 shifts, at	17 25	828 00
Blower.		
⅘ engineer	3 75	
⅘ wood for engine	2 40	
⅘ oil and lights	45	
⅘ repairs, &c	37	
48 shifts, at	6 97	334 56
Crusher.		
Running ⅓ time, reduced to 48 shifts:		
⅓ engineer	1 25	
⅓ wood for engine	80	
⅓ oil and lights	15	
⅓ repairs, &c	12	
⅓ repairs on crusher	72	
⅓ man to feed	2 00	
48 shifts, at	5 04	241 92

Fluxes.

1.8 tons roasted pyrites, at $14.30	$25 74	
Scrap iron, lime, &c	85	
48 shifts, at	26 59	$1,276 32

Losses.

3.7 tons slag, assaying 43 ounces silow	15 91	
48 shifts, at	15 91	763 68

Miscellaneous expenses.

1 man wheeling charges, half-time.	
48 shifts, at $2	96 00
Oil, lights, and candles	61 00
⅓ office expenses	333 33
Wear on tools, tuyeres, &c	68 00

During the above campaign there were produced 58.3 tons of regulus, which was crushed, calcined, and smelted through with sandstone flux at the end of the ore campaign and before the furnace was blown out. The expenses of matte concentration were as follows:

Breaking and transporting to crusher, (estimated)	24 00
Crushing	62 50
Calcining, (58 shifts, at $7.12)	412 96
Charcoal	517 44
Labor	181 12
Blower	73 18
Flux, (12 tons sandstone, at $46.15)	49 80
Oil, lights, office, &c	162 00

Blowing out and repairing.

4 men, 4 shifts, at an average of $4.40	70 40
Mason, 3 shifts, at $6	18 00
Helper, 3 shifts, at $3	9 00
320 fire-brick, at $240 per M	76 80
1,100 pounds fire-clay, at $60 per ton	33 00
Extra labor, cleaning up, &c	10 50
Grand total	8,243 16

I have estimated no losses from the matte concentration, as the slag therefrom contained a large percentage of iron, and is used over with ores, forming a valuable flux.

The amount smelted per shift averaged 4.5 tons of charge, or 2.7 tons of ore, making for 48 shifts a total of 129.6 tons of ore, costing to smelt into marketable regulus $63.61 per ton. If it had not been for the unfortunate occurrence of heavy spar in the ore, the matte concentration could have been omitted, and the cost of smelting would have been reduced to $52.16 per ton.

In August, 1873, I built for the company a common reverberatory, which ran steadily until January 25, of this year. It is now standing idle for want of ore. The hearth is 15 feet long, by 9½ feet wide, and accommodates about 2¾ tons of ore at a charge. As the furnace requires a new hearth and extensive repairs only once in six to nine months, I have charged the single month's running with one-sixth of this expense. In 30 days, or 60 shifts, the furnace loses on an average three shifts. The ores require no calcining, and the matte produced is sufficiently rich for shipment. At present, however, I am separating it in the wet way with satisfactory results, and at a very moderate expense. The cost of smelting is given in detail below:

ORE-SMELTING IN THE REVERBERATORY.

30 DAYS OR 60 SHIFTS.

1-6 expenses of putting in hearth	$41 00
Average repairs for 60 shifts	29 50

Fuel.

4¼ cords wood per shift, at $3.50	$14 87	
57 shifts, at	14 87	847 60
114 bushels charcoal, at 15 cents		17 10

Labor.		
1 smelter	$5 00	
1 helper	4 00	
1 fireman	4 00	
57 shifts, at	13 00	$741 00
Crusher.		
Same as for blast furnace	5 04	
57 shifts, at	5 04	287 28
Fluxes.		
0.6 ton pyrites, at $14.30	8 58	
Lime, &c	30	
57 shifts, at	8 88	506 16
Losses.		
2.6 tons slag, assaying 7.5 ounces silver	19 50	
57 shifts, at	19 50	1,111 50
Miscellaneous.		
Wheeling charges		114 00
Oil, lights, &c		79 60
⅓ office expenses		333 33
Wear on rabbles, tools, &c		132 00
Regular repairs.		
300 pounds clay, 400 pounds quartz, 57 shifts, at $3.35		190 95
1-6 blowing out and repairing		57 00
Grand total		4,488 02

During this campaign of 57 working-shifts there were smelted 153.9 tons of ore, yielding 19.4 tons of very rich regulus. The actual cost of producing the same was $29.16 per ton. This shows an enormous saving in the use of the reverberatory furnace, and for several months the blast-furnace has lain idle, except when engaged in smelting through small batches of lead ores.

I make no further comments on the subject, but simply re-assert that all the above figures are from actual work, and can be accepted as reliable

CHAPTER XIV.

LEAD AND SILVER SMELTING IN CHICAGO.

This chapter was prepared by Mr. Joseph L. Jernegan, mining engineer, late of the Chicago Works, for presentation to the American Institute of Mining Engineers. I republish it from the columns of the Engineering and Mining Journal of New York, the official organ of the institute. It is specially interesting as furnishing an account of the Balbach modification of the Parkes desilverization process, and thus completing the information given in Chapter XV below.

In this paper I propose to give a short and, as I must confess, a rather incomplete description as regards many details, of the process used in Chicago, Ill., for the smelting of the argentiferous ores of the far West, and shall confine myself in this description principally to the process made use of at the Chicago Silver Smelting and Refining Company's Works, known as the Balbach process, as all the other smelting-works in that city follow the same method, with the exception of one, which has the Cordurié process for the desilverization of argentiferous lead. In all there are five silver smelting and refining works in and near the city of Chicago.

The Chicago Silver Smelting and Refining Company's Works are situated at the little station of South Lynne, on the Chicago, Peoria and Saint Louis Railroad, about seven miles south from Chicago.

The plant at these works consists of one horizontal steam-engine, principally used for running the ore-pulverizer, one ore-pulverizer, four reverberatory smelting-furnaces, connected by horizontal flues with a common chimney 85 feet high, three lead-softening furnaces, one so-called zinc or mixing furnace, one separating-furnace or liquation-hearth, one lead-refining furnace, three zinc-distillation retorts, one English cupellation-furnace, supplied with blast by a No. 3 Sturtevant blower, which is run by a small steam-engine having a vertical tubular boiler, and an assay-office, in which there are two wind-furnaces, of the ordinary construction, and also a small muffle-furnace. The assay-office is supplied with all the necessary apparatus and reagents for fire-assaying. There are also a superintendent's office, various store-rooms for coke and charcoal, and for the preparation of fire-clay, &c. Recently a small slag-hearth, (Krummofen,) with one tuyere, has been put up for the purpose of working over again such slag as assays too high in silver and lead to be thrown away, of which there are large amounts.

The principal ore worked, while I was in the employ of the company, was that of the well-known Emma mine, in Utah, and also small quanities of Colorado ore. The character of the Emma ore is well known to most members of the institute. It consists principally of ferruginous mixtures of carbonate and oxide of lead, oxide of iron, and antimony, with nodules of galena. A greater part of this ore received at the works looks exactly like ordinary sand. The ore is delivered to the works from the railroad in bags, weighing on an average 100 pounds each, which are piled up in stacks ready for smelting, the ore being already in a fine enough state (most of it too fine) to enter the smelting-furnaces. I here give an analysis of the Emma ore taken from the report of the Government Commissioner on Mines and Mining in the States and Territories West of the Rocky Mountains for 1871. The sample taken was an average one of 82 tons of first-class ore, and the analysis was made by James P. Merry, of Swansea, April, 1871.

Silica	40.90	Alumina	0.35
Lead	34.14	Magnesia	0.25
Sulphur	2.37	Lime	0.72
Antimony	2.27	Carbonic acid	1.50
Copper	0.83		
Zinc	2.92		90.42
Manganese	0.15	Oxygen and water by difference	9.58
Iron	3.54		
Silver	0.48	Total	100.00

SMELTING IN REVERBERATORY FURNACES.

Strange to say, this ore is smelted in reverberatory furnaces, and when one comes to consider the amount of silica contained therein, viz: over 40 per cent., according to the analysis just given, it must be immediately perceived that this method is entirely contrary to all metallurgical principles. Kerl, in his *Handbuch der Metallurgischen Hüttenkünde*, vol. ii., page 89, says of the *Vienne Schmelzmethode* (Vienne smelting process), in vogue in the Department of Poitou, a process of smelting pure galena ores that contain about 5 per cent. silica, with metallic iron in reverberatory furnaces, that "it is adapted to pure galena ores, poor in silver, that contain so much silica, (over 5 per cent.), clay or silicates, that they cannot be worked in a reverberatory furnace in the customary manner." "Rich argentiferous ores, or poor lead ores, having the above gangue, can be more economically smelted in shaft furnaces." The Swansea Silver Smelting and Refining Works, situated on Jefferson street, Chicago, where large quantities of Emma and Flagstaff ores are smelted, seem to be coming to this conclusion, as lately two new blast furnaces have been built and are now running, as I hear, with good results; also the works of C. P. Lunton, Forty-second street, have just erected one.

The smelting charge is dumped on the floor before the reverberatory furnaces, and there well mixed together. The furnace doors are then raised, and two men with shovels shovel the charge into the furnace as quickly as possible, after which the doors are immediately closed, and the smelter then urges his fire to its utmost. Below is given one of the statements of furnace No. 1. It is a good average example of what one of the furnaces puts through in 24 hours, although it is more often the case that only five charges are put through daily, whereas in this case we have six. This example applies, of course, to a furnace that is in good running order. This schedule shows the number of charges put through in 24 hours, the number of the several charges, the pounds of ore, dross, and litharge, as well as the amount of different fluxes used in each charge, the amount of bullion produced, and assay of silver of same, and several other items:

Reverberatory furnace—daily statement, 1873.

Date.	Number.		Ores, &c.			Fluxes.				Time.		Bullion produced.		Silver.
	Furnace.	Charge.	Emma.	Dross.	Litharge.	Lime.	Salt.	Spar.	Iron.	Hours.	Minutes.	Pounds.	Assay in silver per ton.	Ounces.
Oct. 15..	1	308	1,220	250	......	50	50	150	150	7	30	544	202	71
Oct. 15..	1	309	1,050	250	......	50	50	150	150	12	35	430	270	60
Oct. 15..	1	310	1,000	250	......	50	50	150	150	4	50	485	270	65
Oct. 15..	1	311	1,025	250	246	50	50	150	150	9	0	323	300	33
Oct. 15..	1	312	1,050	250	200	50	50	150	150	1	0	648	236	82
Oct. 15..	1	313	1,035	250	200	50	50	150	150	5	30	435	250	54
			6,380	1,500	646	300	300	900	900			2,885		365

Whether the analysis given above of the Emma ore would be accurate for the ore smelted during the time I was in the employ of the company I cannot say. I presume it would agree very closely. I shall therefore make free use of it in what criticisms I may make upon the process.

It will be seen by the above statement that in twenty-four hours 6,380 pounds of Emma ore + 1,500 pounds of lead dross + 646 pounds litharge were worked with 300 pounds limestone + 300 pounds salt + 900 pounds fluor-spar + 900 pounds iron-borings, or 8,526 pounds of argentiferous lead-matter, with 2,400 pounds fluxes, equal together to 10,926 pounds, or about 5½ tons. The amount of fluxes used is equal to about 28 per cent. of the ore, dross, and litharge. Pounds of argentiferous lead (bullion) produced = 2,885 pounds, containing 365 Troy ounces of silver.

Now, say that this ore assayed 30 per cent. Pb., which is very low, as it generally runs between 40 and 50 per cent., then theoretically there should be produced from these 6,380 pounds of ore 1,914 pounds of lead, and as of the 1,500 pounds of dross not quite all is lead, we will say that 90 per cent. of it is lead; then, if none of it were lost in its extraction, there should be produced from this amount 1,350 pounds of lead. Then we have 646 pounds of litharge, containing theoretically about 90 per cent. Pb., which, if it were all extracted without loss, would make 581 pounds more of lead. Now, 1,914 + 1,350 + 581 = 3,845 pounds of lead, the theoretical amount to be produced, which is more than 2,885 pounds, the amount actually produced, by 960 pounds, making a loss in this case of about 24 per cent. of the lead contained in the charge, and it must also not be forgotten that the percentage of lead contained in the ore has been taken at a very low figure.

Where does this lead go? is now the question. My answer is: First, some of the ore (it generally being in a sandy state) can be carried up the chimney by means of the strong draught passing through the furnace; and the longer the time is before the ore begins to agglomerate, the greater is the amount that can be lost in this manner; second, by volatilization, as lead volatilizes at all temperatures above its fusing-point, (334° C.;) and, third, by forming with the slag a silicate of lead, and also by becoming entangled in the same in a metallic state, it not having time to settle down to the bottom of the pot into which it runs when the furnace is tapped, either on account of the slag being cooled off too rapidly or because it is too pasty; or, in other words, is not always a singulo-silicate. To remedy the first case, such ores as are in such a finely-divided state should be agglutinated with milk of lime before entering the furnace; for the second case, about all that can be done is to provide the furnaces with well-arranged condensation-chambers; and as for the third case, the best thing to be done would be to smelt the ore in shaft-furnaces, instead of in reverberatory furnaces; but even in making use of the reverberatory furnaces, the entanglement of the lead in the slag could be prevented by forming a singulo-silicate and also by allowing the charge, when tapped, to run into one large pot only, instead of into three small ones, as is the case at present.

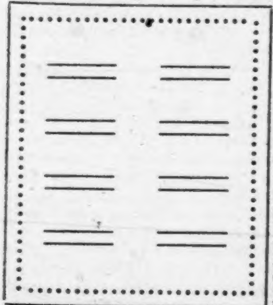
By allowing the charge to run into one pot only, the slag would take more time to cool off, and would thus give such lead as had become entangled in the slag more opportunity and time to settle to the bottom of the pot. I have at times seen parts of a slag or lead-stone, as it is called in this case, literally full of metallic globules of lead, from the size of a pea up to that of an egg. Such slag, of course, is put through the furnace again. What little matte is formed is generally so intimately mixed with the slag that one would not be able to say whether there were any or not.

I am sorry to say that the assay-value in silver of the ore worked upon the particular day, as made use of above for an example of the charges put through a reverberatory furnace, has slipped my memory, and I have no means of finding it out; consequently, I have not been able to follow up the silver in its passage through the furnace as I have done with the lead. This is much to be regretted. However, where metallic lead is found in the slag, there must also be silver with it, and this has been proved by numerous assays.

By looking at the analysis again, we find that the ore contains 3.37 per cent. of sulphur, and we will call the average 5 per cent. Five per cent. of 6,380 pounds of ore = 319; and as 16 parts of sulphur require 28 parts of iron, 319 parts would require 558 of iron, which is less, by 342 pounds, than 900 pounds, the amount used; therefore, according to the case supposed, 342 pounds of iron more than is necessary is daily used in each of the furnaces, and as a pretty good price is paid for the iron-borings, as well as for carting the same from the city to the works, this waste of material becomes a source of considerable financial loss within a year's time, equal in this case to the cost of 342 pounds of iron-borings multiplied by 365, the number of days in a year, which is 124,830 pounds = 62.4 tons per furnace. Another source of useless expenditure is the salt used, which is supposed to act as a flux; but, as every metallurgist knows, it only rises to the top of the charge and there remains. Every assayer observes this every time he makes a crucible assay of ore. Some claim that the salt is not used as a flux, but merely serves the purpose of a covering or blanket to the molten charge, but then cinder, which is produced in large quantities at all metallurgical establishments, would serve the same purpose, and, besides that, would cost nothing; at the same time it would not be influential in the volatilization of lead, as salt undoubtedly is, by forming a chloride of that metal, which is very volatile.

A charge remains in the furnace for about the space of five hours, when the furnace is in good condition and running order. The manipulation is as follows, viz:

As soon as the charge has been shoveled into the furnace through the side doors, it is spread out evenly over the surface with an iron rabble, the furnace-doors are then closed, and the smelter urges his fire to its utmost, in order to melt down the charge as quickly as possible. As soon as the charge has become fluid, one of the furnace-doors is opened and the charge is rabbled, in order to knock off all accretions of unfused matter that may be adhering to the sides and bottom of the hearth; the door is then again closed. The fire-place is kept continually supplied with fuel. The process is said to be finished when the slag is in a thin fluid state. As soon as this period is reached, the charge is again thoroughly rabbled, and about fifteen minutes afterward the furnace is tapped, and the molten charge flows out into a large cast-iron pot, from which, when full, the slag flows over into another pot of a smaller size at its side. There is also a third pot by the side of the second, in case the charge should be so large as to fill the first two. While the slag is still hot, an iron staple is sunk for about two-thirds of its length into the same, and the slag is allowed to solidify around it. When the slag has become solid, it is lifted from the liquid lead in the bottom of the pot by means of a hook passed through the staple in the slag. The hook is fastened to an iron chain, which runs over a pulley, and the slag is hoisted out of the pot, placed upon a two-wheeled wagon, and carted to the dump. Here the block is broken open with a sledge-hammer, and if it contains any visible particles of metallic lead, the rich parts are separated from the rest for a second treatment. The argentiferous lead in the bottom jo the pot is ladled out into cast-iron molds.



Of the four reverberatory furnaces at the works in South Lynne, only two are generally kept running at a time, while the other two are in repair.

The furnaces, when new, absorb much lead, and leak badly. At one time several tons of lead were melted out from the hearth of one of the furnaces by building a wood-fire underneath the hearth-plate. The hearth of the furnace rests upon an iron plate, which in its turn is supported by walls of masonry running crosswise, of which there are five or six. Now, when a furnace has finished its campaign, and is allowed to cool off for repairs, and is then heated up again for further work, this iron plate is very apt to become warped. The plate, on becoming warped, is apt to displace the fire-brick composing the hearth, and in this manner the furnace becomes leaky. They were troubled the same way at the Swansea works, and there the superintendent had an iron pan made, into which the iron plate of the furnace was placed, it resting on wrought-iron bars, placed as shown in the accompanying sketch.

The continuous line represents the outer edge of the pan, and the dotted line the furnace-plate; the other lines the iron bars upon which the plate rests in the pan. After the pan has been placed upon the walls of masonry, the iron bars are put in the pan in the order shown in the sketch, and immediately over the walls of masonry. Upon these bars the furnace-plate is placed, and the hearth of the furnace built upon it with fire-brick. When the furnace is in work, it is kept continually supplied with water, which keeps the iron plate at a constant low temperature, and in this manner it is kept from warping. The water in the pan evaporates quite rapidly, but is supplied with fresh as fast as it goes off. Hearing that this arrangement worked very satisfactorily, it was tried with one of the furnaces at South Lynne, and it worked to our perfect satisfaction.

LEAD-SOFTENING.

As the silver-lead, or bullion, as it is generally called, from the reverberatory furnaces is very hard, containing always a large percentage of antimony and other impurities, it is first put through lead-softening or refining furnaces, before being treated with zinc for the extraction of the silver.

The furnaces are small reverberatories, having working-doors on one side and a tap-hole opposite, below which there is an iron pot sunk into the floor of the building, large enough to hold the charge of lead which the furnace is able to put through at one time. This pot stands over a fire-place, and the lead can thus be kept in a molten state as long as is required. There are three of these furnaces at South Lynne.

With bullion produced from the Emma ore, a large quantity of dross is formed in softening it, and the time necessary for the operation depends, of course, upon the purity of the bullion. The manipulation is as follows:

After the requisite number of bars of lead have been placed upon the hearth of the furnace by means of the charging iron, the furnace-door is closed, and the charge slowly melted down. As soon as any dross forms on the surface of the bath, it is removed from the furnace with an iron rabble. The workmen are very apt to pull out a large amount of lead in removing the dross by means of this very heavy implement, and if, as at Freiberg, in Saxony, a piece of green wood were used, fastened on crosswise to a long iron rod, instead of the rabble, I think much less lead would be taken out with the dross. When the lead has become softened to the degree intended, the furnace-man fires up for about fifteen minutes quite energetically; the furnace is then tapped, and the lead flows out into the iron pot below. The surface of the lead is then skimmed clear of any oxides that may have formed there, and it is then dipped out into molds. The dross produced is sent back to the reverberatory furnaces for reduction.

FIRST LIQUATION AND MIXING WITH ZINC.

The zinc-furnace, as it is called in Chicago, is nothing more nor less than a liquation-furnace, used for liquating the bullion, in order to free it from such impurities as may not have been eliminated in its passage through the lead-softening furnace, previous to its being mixed with zinc for the purpose of desilverization.

The hearth of this furnace is formed by two iron plates, so placed together that they form a trough, and the trough thus formed has a slight inclination from the fire-bridge toward the tap-hole in the front part of the furnace. Immediately in front of the tap-hole there is a short spout of cast iron, from which the lead slowly runs down into a cast-iron pot sunk into the floor. This iron pot is provided with a fire-place, in order to keep the lead in a fluid state. While the furnace is putting a charge through, a small fire is kept up by a few coals on the tap-hole spout, so that the lead will not congeal there. About 20 pigs of bullion compose a charge, and it requires between three and four hours to run a charge properly through. The higher the temperature in the furnace the quicker the charge is run through, of course, but then the liquated bullion is impurer than when run through more slowly. As lead fuses at 334° C., the temperature in the furnace should be kept as near this point as possible, in order to melt out the lead only and leave its impurities on the hearth in the form of dross. The fire, therefore, that is kept up, is a very low one, and the fire-door is generally left open. The lead trickles slowly down the hearth toward the tap-hole, and from there runs into the heated pot below. The dross left on the hearth is removed when no more lead melts out from it, and is sent back to the reverberatory furnaces for reduction. The argentiferous lead now in the pot is mixed with about 3 to 4 per cent. zinc, and stirred continually with a perforated ladle for about forty minutes, when it is dipped out into iron molds and sent to the separating-furnace. Below are given a few examples of what the furnace puts through and brings out, and also the amount of zinc mixed with the argentiferous lead for the extraction of its silver:

ZINC-FURNACE.

Date.	Time.	Bars in.	Weight.	Zinc.	Bars out.	Remarks.
October 25, 1873	10.45 a. m.	22	2,215	88	22	Hussey bullion.
October 25, 1873	3.00 p. m.	21	2,170	85	22	Do.
October 25, 1873	6.00 p. m.	21	1,995	80	21	Emma bullion.
October 25, 1873	8.45 p. m.	21	2,070	80	21	Do.
October 26, 1873	12.00 m.	21	2,000	80	21	Do.

The above gives the date and time when the charge enters the furnace, number of bars composing the same, weight of bars, amount of zinc in pounds mixed with the argentiferous lead, and number of bars after ladling out. I regret that the amount of dross produced by the bullion is not given, as generally no account was kept of it as should have been.

At the Swansea Works sixty pounds of zinc are mixed with every ton of argentiferous lead. The above table shows that more than this is generally used at South Lynne.

The bullion at the latter works does not, I believe, generally assay so high in silver as that of the former, but I am inclined to think that the refined lead sent away from the works at South Lynne generally contains less silver per ton than that from the Swansea, and the probable reason for it is in the larger proportion of zinc used at South Lynne.

SECOND LIQUATION AND SEPARATION.

The second liquation or so-called separation furnace are similar to the zinc furnace in its construction, with the exception that the hearth of the separating-furnace has not as great an incline from the fire-bridge toward the tap-hole as that of the zinc-furnace. On the floor, immediately in front of the charging-door, there is an iron plate, upon which the argentiferous zinc dross is stirred about with a shovel after coming out of the furnace, in order to somewhat decrease the size of the larger lumps before entering the zinc distillation-retorts. The manipulation of running the argentiferous lead mixed with zinc through this furnace is about the same as with the zinc furnace, with the exception that it must be done with much more care, and, at the same time, more slowly, if a thorough separation of the silver from the lead is to be obtained. As lead fuses at 334° C., and zinc at 411° C., the utmost care must be given to the fire, so that the temperature in the furnace may be sufficient to melt out the lead only, and to leave the argentiferous zinc dross remaining on the hearth with as little lead as possible. The longer the process lasts, that is, the more time consumed in liquating the lead, the less silver there will be found in the same, if, previous to its liquation, it has been properly mixed and thoroughly stirred with a sufficient amount of zinc. When the charge had been properly manipulated it often happened that I was unable to find a trace of silver in the desilverized lead by cupelling one-third of an assay ton or 9.722 grammes. But, on the other hand, when poor zinc scrap had been used, instead of good slab zinc, the desilverized lead would sometimes assay as high as 18 ounces to the ton, even when the zinc had been well mixed with the lead and slowly liquated. This zinc scrap made use of for a short time was undoubtedly principally composed of iron.

Below is a schedule in which are given the date and time of charge entering the furnace, number of charge, number of bars composing the same, number of bars of desilverized lead produced, weight of same, amount of silver per ton contained therein, and also the quantity in pounds of argentiferous zinc dross produced. Charge No. 23 was in the furnace seven hours and ten minutes; charge No. 24, eight hours and thirty-four minutes; charge No. 25, six hours and sixteen minutes; charge No. 26, eight hours; and charge No. 27, nine hours and thirty minutes.

SEPARATING-FURNACE.

Date.	Time.	Number of charge.	Bars in.	Bars out.	Weight.	Assay.	Dross produced.
October 28, 1873	6.30 p. m.	23	20	17	1,643	Trace	270
October 29, 1873	1.40 a. m.	24	20	16	1,594	Clear	200
October 29, 1873	10.14 a. m.	25	20	18	1,732	2-5 ounce	240
October 29, 1873	5.30 p. m.	26	20	17	1,650	3-5 ounce	220
October 30, 1873	1.30 a. m.	27	20	17	1,625	Trace	181
October 30, 1873	10.00 a. m.	28	20	18	1,764	Clear	169

LEAD-REFINING.

Before following up the argentiferous zinc dross we will first finish with the desilverized lead, and then return to the former subject. After the desilverized lead has been ladled out of the pot belonging to the separating-furnace into iron molds, it is sent to the lead-refining furnace for further treatment.

The lead-refining furnace is an ordinary reverberatory furnace with charging and fire doors on one side and tap-hole on the opposite. A charge consists of about 25 bars, the bars averaging about 100 pounds in weight. The principal impurity to be eliminated from the lead in its present state is zinc, if the other impurities, such as antimony, arsenic, copper, iron, &c., have already been well removed during the processes of lead-softening and liquation, which took place previous to the bullion being mixed with zinc. The charge remains in the furnace between three and four hours, depending of course upon the quality of the lead. Formerly the lead produced at the works in South Lynne had a good reputation as fine soft lead, but of late the process of refining has not been carried so far as formerly, as only lead adequate for pipe purposes was desired. Below is a statement for several days of what the furnace put through with its production in marketable lead, also the date and time of charge entering furnace, number of the charge, number of pigs of refined lead produced, and assay in silver per ton of the same. When the charge is finished, the lead is allowed to flow into a cast-iron pot that is provided with a fire-place. Saw-dust is strewn over the surface of the lead in the pot to prevent its oxidizing. The lead is then ladled out into iron molds having the impress of the company's name on the bottom. When two or three molds have been filled the oxide formed on the surface of the lead is smoothly scraped off, in order to give the pigs a smooth and bright appearance. The metal having become cool it is dumped out of the molds, piled up, and is then ready for shipment.

LEAD-REFINING FURNACE.

Date.	Time.	Number of charge.	Bars in.	Bars out.	Assay.
October 22, 1873	12.30 p. m.	47	25	33	2 ounces per ton.
October 23, 1873	9.00 a. m.	48	24	31	Trace.
October 25, 1873	8.30 a. m.	49	25	31	Clear.
October 25, 1873	1.30 p. m.	50	26	33	Clear.
October 26, 1873	8.30 p. m.	51	26	36	2 ounces per ton.

The molds into which the refined lead is ladled are smaller than the other molds in use.

ZINC DISTILLATION IN RETORTS.

We will now return to the subject of the extraction of the silver from the argentiferous dross. This dross is principally composed of zinc, lead, and silver, and sometimes contains a considerable amount of antimony, if the bullion contains a large amount of that metal which has not been thoroughly eliminated during the process of lead-softening and liquation. When the argentiferous zinc dross contains a large percentage of antimony, the process of distillation is much retarded and the retorts become worthless in a much shorter time than when the dross is free from that metal.

The retorts are made of fire-clay and are placed in an inclined position within the tilting retort-furnace invented by Mr. Faber du Faur. The furnace is held together by means of cast-iron buck-staves and wrought-iron rods. The general shape of the wind-furnace is that of a hollow cube. The bottom is of wrought-iron bars, which constitute the fire-grate; the top is arched over, but in the center of the arch there is left a square hole, which serves as the charging-hole for fuel. There is also an aperture in the front side through which the neck of the retort slightly projects. The space left between the neck of the retort and the sides of this aperture is tightly stuffed with fire-clay. On the rear side, almost two-thirds of the way up from the bottom, there is a small square hole connecting with a short horizontal flue, that passes into an aperture in the lower part of the chimney. At the works at South Lynne there are three of these retort wind-furnaces situated around the same chimney. They are all invertable by means of a simple piece of mechanism, consisting of the axle of the wind-furnace, supported on cast-iron feet, and of a small cog-wheel attached to one end of the axle, into which plays a worm, which, on being turned by means of a hand-wheel, revolves the furnace on its axle. By this means the retort and furnace can be turned nearly upside down, thus emptying the retort of its contents. Coke is the fuel used. When the retort-furnace is filled up to the top with burning coke, the retort is completely surrounded on all sides with live coals. The temperature existing within the retort must be very high, as it is that of a white heat. I think it cannot be doubted but what it is sufficiently high to volatilize silver, especially as it will be more disposed to volatilize in conjunction with the distilling zinc. Some silver is also undoubtedly carried off mechanically with the zinc as it distils over. I regret very much that I am not able to give any new facts relating to this important and interesting subject, as I had no opportunity of making experiments. The apparatus thus imperfectly described is patented by Mr. Balbach, of Newark, N. J., and also the zinc and separating furnaces before spoken of.

The argentiferous zinc dross, after being mixed with small pieces of charcoal, is put into the retorts with a scoop, as soon as the retort has become sufficiently heated. The retorts are filled full up to the neck, and as the distillation progresses more charcoal is added to the contents of the retort from time to time, as deemed necessary. As soon as the zinc begins to distil over, (known by the white fumes of zinc oxide that escape from the mouth of the retort,) a hollow conical-shaped prolongation of fire-clay, called a nose, is placed before the mouth of the retort, in order to condense as much metallic zinc as possible. As fast as zinc condenses in the nose, it is removed with a small iron rod, hooked at one end, by passing it into the orifice of the prolongation, by the retort-man. The zinc fumes (zinc oxide) issuing from the end of the nose pass off into the atmosphere through a sheet-iron pipe, that passes through the roof of the building into the open air. A very small quantity of the oxide is saved, namely, that which accumulates on the inside of the sheet-iron pipe. About 50 per cent. of the zinc is regained as metallic zinc, through its condensation in the noses.

The distillation is known to be progressing well, when there can be seen at the end of the nose a small flame having the characteristic pale-yellowish-green color of zinc, when it burns to oxide, and when accompanied with voluminous white clouds of zinc oxide. The flame is much brighter and larger when the distillation is taking place in a new retort, than in one which has been used for several times; the disengagement of zinc fumes is also more energetic.

The retort-man must give his almost constant attention to the nose of the retort, and see to it that the passage is kept continually free, for if it should become stopped up with condensed zinc, there would be danger of an explosion. More attention is required to this point during the first part of the distillation than toward the latter, as it is then that the distillation is the most energetic. When the zinc flame is no more visible and zinc fumes are evolved in only small quantities, the nose is removed and the retort left to itself until scarcely any more fumes are perceptible issuing from the mouth of the same. When the process is finished, the furnace with its retort is so inclined as to allow the contents of the retort to flow out into a small iron pot, held and carried by two workmen. The rich argentiferous lead thus obtained is poured from the pot into iron molds, making bars about 1½ feet long, 2 inches thick, and about 3 inches wide at the top, and which are so light, that they can be placed upon the test of the cupellation-furnace without injuring it. This retort-bullion assays between 2,000 and 3,000 ounces in silver per ton of 2,000 pounds, depending, of course, on the richness of the ore worked.

After the retort has been emptied of its contents, and well scraped out, it is turned right side up again, and is ready, if in good condition, for another charge; if not, the grate-bars must be taken out, the coke removed, and retort and furnace allowed to cool off, after which the old retort is taken out and a new one set in. After the furnace has become cool, it takes but a short time to remove the old retort and replace it with one that is new. The retorts used at South Lynne were generally unfit for further use after having put through about nine or ten charges, they becoming after this so clogged on the interior with zinc oxide, and covered over on the outside with a thick crust of slag, formed from the ash of the coke, that it became difficult to heat them to that degree in which zinc freely volatilizes. It is considered more economical, therefore, to do away with the retorts as soon as they become so worn that the process of distillation would be prolonged by their further use, and it is considered better to economize in time than in retorts.

Below is given the number of the retort, date and time of charge entering same, number of the charge, number of pounds of dross composing same, number of bars produced, weight of same, and amount of metallic zinc regained by condensation. The amount of oxide saved is not given, it being a very small part of the whole evolved. What little quantity is saved is sold.

RETORT NUMBER 1.

Date.	Time.	No. of charge.	Dross, lbs. of.	Bars out.	Weight, lbs.	Zinc regained, lbs.
November 2, 1873	4.00 a. m.	5	299	36	203	34
November 3, 1873	6.00 p. m.	6	319	36	195	58
November 4, 1873	3.00 p. m.	7	320	36	179	59
November 5, 1873	8.00 p. m.	8	245	31	141	38

It will be perceived by the above statement that a charge consists of about 300 pounds dross, and remains in the retort—charge No. 5, for about thirty-eight hours, charge No. 6 for twenty-one hours, and charge No. 7 for twenty-nine hours; and the average time in these three cases would consequently be 29⅓ hours.

The metallic zinc saved is used again for the desilverization of the silver-lead.

At the silver smelting and refining works on Forty-second street, belonging to C. P. Lunt, I notice that they make use of the old retorts in condensing the zinc in the following manner: The retort is cut in half, the lower half being luted on to the retort-furnace immediately in front of the mouth of the retort. Through the bottom a small hole is knocked, to allow the escape of the zinc fumes. Whether more zinc is brought to condensation in this manner than by the use of fire-clay noses I am unable to state.

CUPELLATION.

The cupellation furnace at the works at South Lynne is a small one, of the English pattern, having one tuyere, supplied with blast by a No. 3 Sturtevant blower. The blower is run by a small steam-engine that has a vertical tubular boiler. The furnace and engine are in a separate room, the floor of which, in front of the furnace, is covered with sheet-iron, so that all pieces of silver that may happen to fall on the floor can easily be swept up. The English style of cupellation-furnace is so generally well known, that a description of the same will not be necessary.

The test is made of a blue limestone, brought from Newark, N. J. It is ground and sifted to the proper size, and then stamped into the iron test-frame. The center of the test is scooped out somewhat in the shape of a horseshoe.

At each cupellation about 6 to 10 silver bricks are produced, weighing on an average about 500 ounces each, and averaging 995 thousandths fine, according to tests made at the governmental assay-office in New York City.

I give here some assays made by myself, which show the amount of silver contained in the litharge at various stages of the cupellation, which in this case lasted for 18 hours. The samples were carefully taken from the litharge every hour, as it ran off the test. These assays show that, as the cupellation nears its end, the greater is the amount of silver dissolved in the litharge, or, in other words, the smaller the proportion of lead to the silver present on the test the richer the litharge will assay in silver. The assays also show that the amount of silver contained in the litharge depends upon the skill with which the operation of cupellation is conducted, for if it were otherwise we should expect that the amount of silver in the litharge would gradually increase from the first assay up to the last, and, as will be perceived, this is in a manner so, but the increase is not gradual; for example, the sample taken in the third hour assays higher in silver than of that taken in the fourth hour. There are several other like cases, which will be found on inspection.

ASSAYS OF SAMPLES OF LITHARGE TAKEN EVERY HOUR DURING THE CUPELLATION.

1st hour	9 oz. = 0.03 per cent.	10th hour	21 oz.
2d hour	18 oz.	11th hour	45 oz.
3d hour	9 oz.	12th hour	19½ oz.
4th hour	18 oz.	13th hour	39 oz.
5th hour	18 oz.	14th hour	25½ oz.
6th hour	12 oz.	15th hour	36 oz.
7th hour	15 oz.	16th hour	49½ oz.
8th hour	15 oz.	17th hour	88½ oz.
9th hour	10½ oz.	18th hour	144 oz. = 0.5 per cent.

I have had the test-bottom to assay as high as 149 ounces per ton in silver. This, of course, as well as the litharge, goes back to the reverberatory furnaces for further treatment.

SILVER REFINING.

The silver bricks from the cupellation-furnace are melted over again in graphite crucibles in the wind-furnaces of the laboratory, with addition of a little quartz-sand and borax, which gives the silver a brighter appearance and also frees it from any litharge that may be with it. It is then poured out into cast-iron molds, stamped, and is then ready to be sent to the New York assay-office.

The silver, in accordance with the Balbach process, must go through seven different processes before it is ready for market, viz:

1st. Smelting and reduction in reverberatory or shaft furnaces; 2d. Softening of the silver-lead; 3d. Liquation and mixing with zinc; 4th. Second liquation in separating-furnace; 5th. Distillation of zinc in retorts; 6th. Cupellation of rich argentiferous lead; and 7th. Refining of silver in crucibles.

CHAPTER XV.

THE WYANDOTTE SMELTING AND REFINING WORKS.

The following account of the processes employed at Wyandotte, Mich., in the treatment of the rich silver ores from Silver Islet mine, in Lake Superior, was prepared by Mr. W. M. Courtis, mining engineer, the manager of the works, and laid before the American Institute of Mining Engineers. This chapter concludes the review of American smelting-works, so far as I am able to give it this year. The student of this and preceding volumes will find almost every establishment of importance in the United States thoroughly described. A few, which have been omitted for various reasons, will be discussed next year, if the necessary data can be obtained.

Several points in the following description deserve particular attention. I may mention especially the very interesting investigation conducted by Dr. Hahn with reference to the solvent power of different chloride solutions for the chloride of silver. The results of this thorough inquiry are striking, and may become highly important in the humid metallurgy of silver. I give the paper as it was presented to the Institute.

Since many accounts of Silver Islet mine, in Lake Superior, have already been published, it is supposed that the members of the Institute are familiar with the location and character of the mine. To many, however, a more detailed account of the ore and manner of treatment will, perhaps, not be without interest.

The extraordinary richness of Silver Islet ores, and the difficulty of obtaining correct assays, induced the company to erect smelting-works of its own. Accordingly, ground was broken at Wyandotte, Mich., early in the spring of 1871, and the work was pressed on with indomitable energy by Capt. E. B. Ward, of Detroit, as president, and Mr. Thomas MacFarlane, the discoverer of Silver Islet, as superintendent of the works, so that by July 1 the works were so far completed that smelting could be commenced.

The intention was to work western ores with those from Lake Superior, since the latter contain but a small amount of lead. Hence the capacity of the works is much larger than is needed for the present yield of the mine. The planned process for treatment was smelting with lead ores, desilverizing the lead by Balbach's process with zinc, cupelling the rich lead, and refining the crude silver.

Since the supply of western ores was uncertain, and prices and freights were high, a sufficient supply could not be obtained; and hitherto the works have been in operation but a few months each year. Yet they have produced a very large amount of silver—931,203 ounces in fine silver up to September 1, 1873.

The process has been smelting for rich lead at once, and cupelling and refining the bullion. In addition has come: treatment of the matte to save the nickel; refining the nickel matte; extracting the silver from the marketable nickel speiss; and treatment of the refuse too poor for smelting.

The works occupy three stone buildings, 150 feet long by 47 and 50 feet wide. The first building contains the offices, laboratories, engine and boiler, No. 8 Root's blower, No. 8 Blake's pump, crushing-room, with Blake's crusher, and two 30-inch mills, Dodge's pan-amalgamator and settler, (used for experiments at present.) The second building has the refining-room, with seven wind refining-furnaces; the cupelling-room, with two large English cupelling-furnaces; the bottom-room, where the tests are prepared; the smelting-room and charging-floors, with a block of four low blast-furnaces (Krummöfen) and two reverberatories; and a blacksmith's and carpenter's shop at the end of the building. In connection with the blast-furnaces is a flue-chamber about 150 feet long and 4 feet square.

The third building contains two cupelling-furnaces, and the plant for the zinc process, with the furnaces for refining 25 tons of bullion daily.

The low blast-furnaces, though perhaps not the most economical for general application, answer their purpose very satisfactorily, and have the advantage of being easily regulated in case a charge should not work well, besides involving but small costs for repairs. The former is a very important item in working ore of about 1,000 ounces. Water-backs have been used, and lately water-blocks at the sides seem to show increased economy in the working of the furnace. These furnaces measure about 4 feet from tuyere to top, 3 feet 3 inches from front to back, 1 foot 9 inches wide at tuyere, and a few inches wider at the mouth; from tuyere to sole, about 15 inches. The sole inclines to the tapping-hole. One tuyere is generally used. At one time the height of the furnace was changed to 14 feet, and two tuyeres were used, but owing to want of ore and other circumstances it was changed back, though the running was quite successful. A campaign in the usual furnace lasts four or five weeks, after which it is best to blow out and put in a new bottom. When brick sides are used, they are by that time cut out so much that the furnace requires greatly increased care in working. The bottom is made of brasque, composed of 3-5 coke and 2-5 fire-clay by measure. A little more fire-clay is usually added in preparing it. The mixture is ground together in the mill until it is as fine as flour. This makes a better bottom than coarser material, as it does not take up the lead, and, if moistened just enough, will not crack.

At first the ore was separated into four classes: A I, containing between 2,000 and 4,000 ounces silver per ton, or 7 to 14 per cent.; II, 600 to 2,000 ounces, or 2 to 7 per cent.; III., above 100 ounces, or 0.3428 per cent.; and IIII, the waste of the mine, averaging 40 ounces, or 0.14 per cent. The latter forms the larger part of the ore and hereafter will be either concentrated or amalgamated, as may prove most economical. At present only two classes are made: smelting ore, which averages between 900 and 1,000 ounces, and No. 4, or waste for the present.

The minerals observed in the ore or gangue are:

Native silver, filiform and massive.
Cerargyrite, where the rock has been decomposed.
Argentite crystallized.
Antimonial silver, (not determined.)
Niccolite.
Annabergite.
Galenite crystallized.
Sphalerite crystallized.
Dolomite.
Rhodochrosite.
Chalcopyrite (rare) crystallized.
Pyrite crystallized.
Marcasite crystallized.
Calcite crystallized.
Graphite.
Quartz.

The presence of the following substances has been proved by tests: cobalt, in the niccolite; gypsum, probably resulting from the decomposition of some sulphurets. As the vein runs under the water of the lake, ore is obtained that has been exposed to its action, both from the vein and as bowlders. The gangue has become quite soft and is usually stained green from the presence of the nickel. The niccolite is so intimately mixed with native silver and sulphurets that it is impossible to say whether the pure niccolite contains silver; but from the tests made it would seem that it does not.

This country-rock is diorite in clay state, pieces of the former being inclosed in the ore. The native silver is generally disseminated through the ore in more or less dendritic masses, the points of native silver forming nuclei for the deposit of niccolite and sulphurets. Sometimes masses are found weighing several pounds. An analysis of a piece of native silver covered with a white powder, gave the following results:

Treated with water it showed HCl, in solution; then treated with acetic acid, it showed CO_2, HCl, CaO, MgO, AgO, FeO; dissolved in conc. NO_5, it left a brown powder of Fe_2O_3, which, treated with HCl, left a black powder, from which NH_4O. dissolved AgCl. The balance was AgS. The mass, therefore, contained more AgS than appears in the following analysis, which shows the composition of the part insoluble in water and acetic acid.

AgCl	4.65
AgS	0.29
Fe	0.26
Cu	0.04
Pb	0.90
Ni and Co	0.02
Sb and As	0.00
	6.16, the balance being fine silver.

The following are analyses of samples of ore prepared for smelting, and represent an average of about thirteen tons for each sample.

ANALYSES OF ORES.

	A I.	I May '72.	I June '73.	IV June '71.	IV June '71.
CaO	7.57	19.39	16.94	23.15	22.90
MgO	6.94	4.35	9.65	6.28	7.73
Al_2O_3	....	......	......	7.53	
Fe_2O_3	1.88	......	......		3.84
Pb	40.24	......	......	......	0.80
Cu	....	......	......	......	......
Zn	2.27	......	......	......	......
Ag	8.30	2.85	......	0.114	0.1445
S	3.36	......	......	1.03	0.64
Silicates	13.23	27.20	30.50	36.13	33.78

Sample A I contained Ni 2.53, Co 0.65, determined by blowpipe analysis, and As 6.85.

The average yield in fine silver of 389 tons, smelted in 1871 was 969.8 ounces per ton, or 3.325 per cent.; in 1872 the average of 350 tons was 911.6 ounces, or 3.126 per cent.

The yield on the assay was for the two years 99.15 per cent., being for the first year about 97½ per cent. and for the second over 100. This was partly due to the difficulty of getting a correct assay; but mostly to the working up of material left as waste the first year.

As there are grains of metallic silver in the ore it is difficult to get correct samples. To approximate as closely as possible, four samples are now made of each lot of 13 tons; three assays are made from each sample, and the mean of the 12 assays is taken as correct for the lot.

The ores used for mixing have been pure galena, argentiferous galenas from Colorado, and ores from Little Cottonwood, Utah, the latter being the most satisfactory. Colorado ores generally contain too much zinc to be used in large quantities with rich ores. Only enough galena is used to furnish sufficient sulphur for a fluid matte.

The fluxes used are limestone and iron cinder from rolling-mills, or iron blast-furnace cinder, when a siliceous slag is required.

ANALYSES OF THE FLUXES.

	Limestone.	Mill-cinder.	Blast-furnace cinder.
CaO	48.47		28.25
MgO	5.03		1.18
Al_2O_3	0.67		9.04
Fe_2O_3		75.06	5.69
Silicates	1.72	SiO_2 .... 25.49	55.25
CO_2 and H_2O	43.41		
	99.30.	100.55.	100.01

The iron cinder has at 8°.3 C., the sp. gr. 4.293, hardness, 5½, fusibility 3, and formula $5FeO, 2SiO_2$.

The blast-furnace slag corresponds to the formula $7 (RO, SiO_2)+Al_2O_3, 3SiO_2$.

The fuel used in the low-blast furnaces has been Hammondville and Connellsville coke, and coke from the Detroit gas-works, trials being made with each. To obtain the value of each, the amount of Silver Islet ore treated is alone taken into account, so that the amount of coke used includes smelting all ores and flux, roasting matte, refining, assaying, and loss in weight.

One ton Hammondville coke treated	0.83 tons ore.
One ton Connellsville coke treated	1.27 tons ore.
One ton gas-works coke treated	1.20 tons ore.

	Hammondville.	Connellsville.	Gas.	Utah coke.
Ashes	15.82	12.93	7.93	9.7
Carbon	74.6	81.1		68.7

Carbon is determined by docimastic assay. The ashes contained by analysis:

	Connellsville (?)	Gas.	Utah coke.
Fe_2O_3	22.73	24.14	59.26
Al_2O_3	25.12	19.69	
CaO	6.95	3.98	5.34
MgO	1.91	1.25	1.74
SiO_2	44.64	51.07	31.37

The first contained 2.23 sulphur, and needs a correction for oxygen.

The ore and flux are made up into charges of about 6 tons, each charge intended for twenty-four hours. Two and a half tons of Silver Islet ore are called a unit, and the proper amount of lead-ore and fluxes is estimated on this basis. The amount of lead in each charge is so arranged that one pound of the silver-lead (*werk blei*) produced will contain one ounce of silver, or between 6 and 7 per cent. silver.

The fluxes are added in proper proportion to produce a basic slag, in which iron predominates; and when the ore is running silliceous, enough lime is supplied to keep the specific gravity of the slag so low that the matte can separate perfectly. About 10 per cent. of slag from the same furnace is added, partly to use up any rich slag, but especially to make the charge more fusible. Old tests, refining-ashes, sweepings, &c., are added in small amounts, in proportion to the production, that there may be no accumulation of silver in unnecessary products. Roasted matte, as well as iron-cinder, is used to make a fluid slag and throw down the lead from the galena. Experience shows that a mixture of both in a charge gives better results and a cleaner slag than either alone. The largest amount of Silver Islet ore put through in twenty-four hours is 2.7 tons to a furnace; the average is about 2 tons, on account of lead-ores being used instead of litharge.

PRODUCTS.

Silver-lead, containing 6 to 8 per cent. of silver, which is cupelled.

Matte.—Enough sulphuret is given to each charge to keep the matte fluid, and prevent the formation of sows. As the ore has but little sulphur, western ores are used, and the matte is only partially roasted. To have the furnace work well, a cake of matte at least 2 inches should be produced with each tapping. If iron-slag is used alone, the matte becomes thick and incloses shots of lead, which makes the assay very high, and consequently, the loss greater.

The matte is roasted in heaps and used over again until the resulting matte contains so much nickel that it can be worked for speiss in the reverberatory furnace. During the roasting there is a partial sweating out of the speiss contained in the matte, so that the lumps that are melted together contain a larger percentage of nickel than that better roasted. These are, therefore, sorted out to be treated in the speiss process. The poorest matte, containing 0.28 per cent. silver, was produced when working Utah ores, which were also favorable to the concentration of the nickel. The following analyses of matte show the increase of nickel as it was worked. The copper and a trace of gold that is found in some of the products come mostly from western ores.

ANALYSES OF MATTES.

	1.	2.	3.
Ni, Co, Zn	1.57	7.32	10.44
Pb	8.17	9.66	3.75
Cu	0	0	0.89
Ag	0.5954	0.5044	0.852
S	16.83	11.48	17.55
Sb	——	2.38	trace
As	——	——	4.18
Slag	——	——	4.75
Fe	72.83	68.66	57.59
Sp. Gr.	6.0672	6.1086	——
Temp.	17°8C	18°3C	——

No. 3 was matte produced in a high furnace. The amount of iron in each analysis is given by difference—not directly determined.

Flue-dust collects in the chambers to the amount of about ¼ per cent. of the material smelted. The largest and richest part settles in the first chamber, that from the chimney containing less than one-third as much as the first chamber.

It is mixed with lime-water to a paste, dried, broken up, and smelted on the charges. The following are analyses of dust:

	1.	2.
CaO	8.74	6.62
MgO	3.66	0
Al_2O_3 Fe_2O_3	14.43	18.54
NiO	0.08	trace
CoO	0.08	
ZnO	6.23	
PbO	19.91	23.77
Ag	0.286	0.292
So_3	9.30	8.85
SiO_2	16.11	13.06
CO_2 H_2O	1.28	3.76
Insoluble, (coke, &c.)	19.13	22.14
	99.25	97.03

Slag.—This is thrown away, except what is wanted for flux, or what is too rich in silver to be rejected.

The assay is generally less than 5 ounces in silver, and sometimes less than 1, while the lead contained is usually less than 1 per cent. If the charges are put up so that the slag will be very poor in silver, the loss in labor and fuel more than balances the saving in silver.

ANALYSES OF SLAG.

	1.	2.	3.	4.	5.
CaO	10.77	15.88	24.99	21.43	17.52
MgO	1.97	3.39	2.46	8.04	4.92
$Al_2 O_3$	2.251	9.56	3.34	1.59	1.78
FeO	41.11	33.80	28.25	16.14	39.36
PbO	....	....	....	1.84	0.81
Ag	0.017	0.026	0.007	0.023	0.02
Sio_3	33.77	37.134	1.46	48.00	34.425
	99.89	99.97	100.61	97.06	98.84

Formula for (1) $13\ RO, 5\ SiO_2 + Al_2 O_3\ 2SiO_3$ Low furnace.
Formula for (2) $14\ (2RO, SiO_2) + 3\ (Al_2 O_3\ 2\ SiO_3)$ Low furnace.
Formula for (3) specific gravity, 3,205 at 17°.8 C.
Formula for (4) $7\ (12RO\ 11SiO_2) + 2\ (Al_2 O_3\ 2SiO_3)$ High furnace.
Formula for (5) Ore smelting in reverberatory, specific gravity, 3. 733 at 64° F.

No. 1 was very fluid; but the charge did not work as fast as No. 3, with not so fluid a slag.

Bricks.—These are divided into two classes, those rich enough to be smelted on the charges, and those that are too poor. When the furnaces are blown out, the brick linings are partly smelted and heavy with lead. Those away from contact with the inside of the furnace are more or less impregnated with lead and silver. The latter is often found filling little cavities, crystallized in octohedrons and nearly pure.

Dressing would be the best way of treating this material, but amalgamation has been used, although a large part of the lead is lost, which also causes the loss of quicksilver to be very heavy.

CUPELLATION OF SILVER-LEAD.

The furnaces are English, with blast below the fire-grate, and on lead bath; the fuel used is Briar Hill soft coal. The tests are made of ground limestone and fire-clay, in the proportion of 3 to 1, stamped into the ring while moist. When full, the tests hold about 650 pounds of silver; but the cupellation ends when there is about 500 pounds, lasting three days, in which 3 to 4 tons of silver-lead have been cupelled, and consuming 1,350 pounds coal per ton. The work done by the cupellers has been improving steadily, the litharge being poorer and a larger amount of lead being put through per hour. As none of the workmen employed have had any previous experience in smelting, it has not been without a great deal of attention that they have attained their present skill. The old tests are broken up by hand to detach the buttons of silver; the part saturated with lead is smelted on the charges, and the balance is mixed with new material to make tests. One test will sometimes outlast two cupellations; but it is safer to use new ones. The greater heat required at the end of the process is apt to injure the bottom, so that flakes come off, thus making the material too thin for a second cupellation.

ANALYSES OF CRUDE SILVER.

	1.	2.
Fe	0.090	0.031
Ni, Co	0.004	0.008
Cu	0.117	0.106
Bi	0.0058	....
Pb	1.090	0.260
Au	0.0023	0.0015
Sb	trace.	....
As	....	....
	1.309	0.407

The balance is silver.

ANALYSES OF LITHARGE.

	First part.	Average.	Last part.
Fe_2O_3	2.82	0.66	1.24
CuO	0.29	0.36	1.41
Ag	0.032	0.072	1.314
SbO_4 AsO_5	1.35	0.62	0.44
	4.49	1.71	4.40

The balance is oxide of lead.

The litharge is used in the charges to supply lead. The crude silver is refined in graphite crucibles and cast into bars weighing 450 ounces. The slag from refining contains shots of silver, and is therefore melted down on the lead-bath in the cupelling-furnace, the skimmings going to the blast-furnace.

The fineness of the bars is 999, and generally 999.5 thousandths, by United States Mint assay.

In the refining slag, which is mostly silicate of lead, (sand being used in refining,) the following metals have been found:

(Ni, Co) O	0.550
Cu O	0.203
Bi O	0.026
Ag	1.837
SbO_4	0.639
AsO_5	0.005
	3.260

NICKEL AND COBALT.

Nickel and cobalt are found in all the products, especially in a green coating that covers the tests, and part of which seems to be a compound of nickel, similar to the *Kupfer-glimmer* found in *Gaar-Kupfer*, containing antimony.

From the analyses of the mattes, it will be seen that the nickel contained in the ore is collected in the matte, the percentage increasing each time the roasted matte goes through the low furnace. When it reaches about 14 per cent., the matte begins to take the appearance of speiss. It is then smelted in the reverberatory, with screenings from the roasting piles, which contain a good deal of arsenic, sulphuret lead-ores, and siliceous chimney-slag, or other material, to take up the oxidized iron. The slag, containing some nickel, goes to the blast-furnace; the silver-lead is cupelled; the matte, poor in nickel, is roasted; and lastly the speiss, containing 25 per cent. of nickel and cobalt, is reserved for further treatment.

The process for treating the speiss has not yet been fully decided upon. At present it is melted on a lead-bath, which takes up about two-thirds of the silver. It is then ground fine, roasted with salt, and the silver extracted with a solution of $CaCl_2$. The residue will be either sold in this state, or, if it proves more profitable, the nickel and cobalt oxides will be extracted. At present, experiments are making to determine which is best. The speiss after leaching shows but a few ounces of silver per ton, and laboratory experiments show that when the proper roasting-furnaces are in use, the loss of silver in residues will be very small. As there are several tons of nickel now on hand in the different products, its value will form a considerable item in the economical working of the ore.

H. C. Hahn, Ph. D., chemist at the works, to whom I am indebted for assistance in preparing this article, and who made all the analyses of the different products, instituted the following experiments to determine the solubility of AgCl in different chlorides used cold. From the table it will be seen that $CaCl_2$ is a much better solvent than NaCl, commonly used in the Augustine process.

At Tajowa, in Hungary, in 1868, a cold solution of salt was used, flowing continuously; and it was our purpose to imitate this process on a small scale, on account of its simplicity. A solution of hyposulphite of soda of the same strength as that used in the Patera process at Joachimsthal would dissolve about twice as much silver as concentrated $CaCl_2$, but the latter is to be recommended, as it dissolves six times more than salt, and can be used in the automatic process of Tajowa.

Table of solubility of AgCl. in different chlorides.

Name.	Salt, percentage.		Saturated at—	AgCl, percentage.	Ag. percentage.	Sp Gr.	Temperature.	Grms. Ag. in 100 c.c.
KCl	24.95		19°.6	0.0776	0.0584	1.1774	19°.6	0.0688
NaCl	25.96	(a)	19°.6	0.1053	0.0793	1.2053	19°.6	0.0956
NH_4Cl	28.45		24°.5	0.3397	0.2551	1.0835	30°	0.2764
$CaCl_2$	41.26		24°.5	0.5713	0.4300	1.4612	30°	0.6283
$MgCl_2$	36.35		24°.5	0.5313	0.3999	1.3350	30°	0.5339
BaCl	27.32		24°.5	0.0570	0.0429	1.3017	30°	0.0558
$FeCl_2$	30.70		—	0.1686	0.1269	1.4199	20°	0.1802
Fe_2Cl_6	37.48	(b)	—	0.0058	0.0044	1.4472	21°.4	0.0064
$MnCl_2$	43.85		24°.5	0.1996	0.1499	1.4851	30°	0.2226
ZnCl	53.34	(b)	—	0.0134	0.0101	1.6005	30°	0.0162
$CuCl_2$	44.48	(b)	24°.5	0.0532	0.0399	1.5726	30°	0.0627
$PbCl_2$	0.99		24°.5	0.0	0.0	1.0094	30°	0.0
$Na_2O_2S_2O$	—		—	—	—	—	—	1.191 (c)
Solution A	—		—	0.2160	—	1.2962	19°.6	—
Solution B	—		—	0.3555 (d)	—	1.3416	19°.6	—
Solution C	—		—	0.5393	—	1.3836	19°.6	—
Solution D	—		—	0.2167	—	1.3023	19°.6	—
Solution E	—		—	0.2013	—	1.3249	19°.6	—

(a) Saturated with $CaSO_4$. (b) Acid. (c) Of the same strength as that used in the Patera process at Joachimsthal. (d) Basic reaction; and, therefore, did not dissolve much silver.

Analyses of solutions.	A.	B.	C.	D.	E.
$CaCl_2$	17.70	33.74	23.60	(a)	(a)
$MgCl_2$	12.55	3.46	11.42		
$FeCl_2$	0.22	—	—	—	—
Fe_2Cl_6	—	—	0.41	—	—
$PbCl_2$	—	—	—	—	2.0715
$MnCl_2$	—	—	0.77	—	—
$NiCl_2$	—	—	0.02	—	—

(a) Amounts not determined; made by dissolving the limestone, of which an analysis has been given. B is also solution of limestone, and A and C are made from No. 4 ore. E is saturated with $PbCl_2$.

The object of trying the compound solutions was to determine the possibility of using some material that was at hand.

A concentrated solution of limestone answers the purpose very well.

Experiments have been made in amalgamating No. 4 ore, over 30 tons having been treated to get an average; and it is intended to continue the experiments to determine whether the large loss in quicksilver is due to the machinery and process used, or results from the character of the ore.

The ore cannot be chloridized, on account of the large amount of lime it contains. After roasting and chloridizing, only 43 per cent. of the silver was produced, while an average of 87 per cent. was obtained by raw amalgamation. The niccolite goes into the amalgam, and, on smelting, the sponge obtained is separated on top of the bullion as a speiss, which contains about 4 per cent. of silver, 8 per cent. of nickel, and 3 per cent. of cobalt.

The bullion is about 666 thousandths fine; or, if the black amalgam is separated and melted alone, two grades are produced—one over .800 fine, and the other .470. As the total amount of metals in this class of ore is about 3 per cent., it is doubtful whether dressing would save as high a percentage as can be got by amalgamation.

The successful working of the poor ores will give an impetus to mining on the North Shore, and many miners that are now under a cloud on account of not finding "that rich strike that would excel Silver Islet," will make their steady profits from the large deposits of low-grade ores, and may not unlikely be surprised at some lucky moment by working into a rich pocket. It is not to be supposed that Silver Islet is something unique, where there are so many good indications.

Were it not for the duties on lead-ores, the North Shore of Lake Superior could provide us with the proper mixture of ores containing gold, silver, lead, copper and nickel, to make practicable the most economical treatment for the products of this rich but poorly-developed region.

Undoubtedly a more complete preparation of the ore at the mines is desirable, thereby saving at least 50 per cent. of the cost of smelting and 90 per cent. of waste. It takes time and skill to put in motion the complicated machinery of a perfected mining enterprise, such as Germany has only just completed, and that, too, with her centuries of experience and skilled rank and file, all well trained to their appointed tasks, from the little boys that roll tamping clay for three farthings a day, to the august *Berghauptmann* who directs the pens of a thousand assistants, collecting, collating, and condensing the figures and experiences of a large empire.

CHAPTER XVI.

THE SMELTING-WORKS OF THE HARZ.

The object of this chapter* is to present, for purposes of comparison with American practice, the exact conditions and methods obtaining at the present time in some of the best metallurgical establishments of the Old World, where the experience of centuries has led to the recognition of principles and the adoption of rules, a knowledge of which must sooner or later become general among the practical metallurgists of this country, if a permanent success is to be here achieved in this branch of industry. Such a knowledge may be arrived at in the United States, as it was reached abroad, by the slow and costly method of experiment; or we may cut short the period of doubt and loss by an intelligent study of the results already achieved. It is certainly not necessary that all the problems of the past history of metallurgy should be worked out again, merely because this is a new country; and it seems to me a matter of direct and weighty importance to our western smelting industry to inquire in what respects the experience gained abroad may be made useful to us. The chapters bearing on such subjects in the present report are intended chiefly for those who are engaged in the treatment of western silver, lead, and copper ores; and the works of the Harz, which constitute the subject of the present chapter, are particularly well suited for the purpose in view, since they deal with ores in many cases identical with those of Colorado, Utah, and Nevada. Indeed, large quantities of American ores have been shipped for treatment to these very works, and the fact that this can be done with profit speaks loudly in favor of the superior system and economy which can thus overcome the disadvantage of five thousand miles of transportation. The simple but thorough and detailed description of the processes of the Harz given in this chapter will furnish numerous hints to American furnace-men of which they will not be slow to take advantage. But in order to secure the full benefit of such an opportunity, and to make the comparison more than a merely implied one, the succeeding chapter has been written upon the avoidable wastes occurring in our western smelting-works.

I should, perhaps, add that these chapters are new and original, containing matter never before published. The latest improvements are included, and the subject is treated exclusively from the standpoint of a desire to confer an immediate and practical benefit on American practice. The technical knowledge and experience and the untiring industry of Mr. Eilers have accomplished, in this instance, a work the value and the difficulty of which practical metallurgists will universally recognize.

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*This chapter has been principally prepared by Mr. A. Eilers, whose reputation as a skillful metallurgist requires no indorsement from me. The weights are usually given in German *centner* (abbreviated ctr.) of 110 pounds (nearly) or 50 kilograms.—R. W. R.

Special acknowledgments are due for friendly reception and assistance, and for communication of all desired details of practice, to the following gentlemen: Berghauptmann Ottiliæ, Oberbergrath Koch, Hüttenmeister Kast, and Obermeister Finke, of Clausthal; Hüttenmeister Bräuning, of Andreasberg; and Hüttenmeister Illing, of Altenau.

I.—FRANKENSCHARN WORKS, CLAUSTHAL.

The processes at these works have been repeatedly and very fully described by various metallurgists. But so constant and untiring is the progressive zeal of the officials that hardly a year passes without some improvement either in the smelting-apparatus or the processes.

At the present time the round furnaces, described and illustrated under the name of the Kast furnace in one of my former reports, are coming more and more into favor. The one Raschette furnace still in existence is only used when over-abundance of ores renders it necessary to work up extra material. The second Raschette furnace is altered into two round furnaces; *i. e.*, two of these smaller furnaces are built into the old outside walls of the former Raschette, so that they touch each other on one side, the middle wall being thus common to both. One large furnace of the Pilz pattern, with eight tuyeres, is also still used, but is not a favorite with the men, as it smelts in twenty-four hours not more than one and a half times the amount of smelting-mixtures which passes through a small round or Kast furnace, though it has twice the number of tuyeres and a diameter one-half larger at the level of the tuyeres than the latter furnace.

The Frankenscharn Works treat the following ores:

1. Dressed galena from the Burgstadt vein-system, with 56 per cent. Pb and 0.09 per cent. Ag.

2. Dressed galena from the Rosenhof vein-system, with 56 to 57 per cent. Pb and 0.08 to 0.09 per cent. Ag.

3. Dressed galena from the Silbermaal vein-system, with 50 per cent. Pb and 0.14 per cent. Ag.

The mine Hülfe Gottes, belonging to this system, furnishes still richer silver-ores, containing 52 to 67 per cent. Pb and 0.18 to 0.21 per cent. Ag. (This vein is in places 18 meters thick.)

4. Dressed ores from the Zellerfeld vein-system, with 50 to 68 per cent. Pb and 0.105 per cent. Ag.

There are small quantities of ores from other veins coming to the works, but the above four furnish by far the largest amounts. Besides these ores considerable quantities of foreign undressed silver-ores have been treated at the works since 1873. But the latter are as yet smelted for themselves, in order to extract the silver as speedily as possible.

The four kinds of dressed galena from home mines are so mixed that the contents of the mixture are throughout the year from 56 to 62 per cent. Pb and from 0.09 to 0.1 per cent. Ag.

According to an analysis by Hampe, made during the latter part of 1869, such an ore-mixture from the different mines as it went then into the smelting-mixture contained—

Quartz, (SiO_2,) (and clay slate ?)	12.874		
Heavy spar, (BaO,SO_3)	1.461		
Calc spar, (CaO,CO_2)	2.380		
Bitter spar, (MgO,CO_2)	0.958		
Carbonate of iron, (FeO,CO_2)	6.749	Fe	3.258
Galena, (PbS)	71.676	Pb	62.08
		S	9.596

Sulphide of silver, (AgS)	0.113	Ag	0.0987
		S	0.014
Sulphide of zinc, (ZnS)	1.980	Zn	1.348
		S	0.632
Copper pyrites, (Cu_2S,Fe_2S_3)	0.911	Cu	0.315
		Fe	0.277
		S	0.319
Iron pyrites, (FeS_2)	0.253	Fe	0.118
		S	0.135
Sulphide of antimony, (SbS_3)	0.537	Sb	0.386
		S	0.151
	99.892		
Total sulphur			10.847 per cent.

This analysis may not absolutely represent the present ore-mixture, but it gives an approximate idea of its composition.

This ore is treated in a smelting-mixture with roasted lead-matte, (containing lead and copper,) copper slag from the Oker Copper Works, (containing 1.5 per cent. Cu and 50 to 54 per cent. Fe,) slag from the same smelting at the Clausthal Works, dressed furnace-scrapings, dust from the condensation chambers, matte-slag, and occasionally also with small quantities of rich litharge, salamanders, and other materials which must be worked up into useful shape.

Usually a charge would be composed about as follows:

Ore	100
Roasted matte	51
Copper slag from Oker	60
Slag from same smelting	93
Dressed furnace-scrapings and *débris*	3
	307

To show late averages of the composition of charges, I give here those smelted in round furnace No. 4 during April, 1873, (thirty days,) and in the Raschette furnace during February of the same year. At the same time, the quantities and contents of useful metals in the products, as well as the fuel used, are given.

1. ROUND FURNACE NO. 4.

Materials in the charge smelted during April, 1873.

	Kilograms.	Calculated for 100 ore.
Dressed ore	102,500	100
Roasted lead-matte	51,250	50
Copper slags from Oker	52,150	50.88
Copper-matte slags from own works	3,300	3.22
Lead-matte slags	32,800	32
Slag from same smelting	75,750	74.88
Rich litharge	500	0.48
Dressed scrapings and *débris*	450	0.44
Dust	1,800	1.75
Total materials	320,500	313.65
Coke used	42,800	41.7
[Calculated for the whole charge this shows a consumption of 13.3 per cent. coke.]		
Products:		
Argentiferous lead	61,400	59.9
Lead matte	68,300	66.63
Slag.		

	Ag.	Pb.	Cu.
The lead contained per cent	0.15		
The lead-matte	0.025 to 0.03	7 to 8	5.5
The slag	0.0007	0.25 to 0.5	

2. RASCHETTE FURNACE.

Materials in the charge smelted during February, 1873.

	Kilograms.	Calculated for 100 ore.
Dressed ore	165,000	100
Roasted matte	64,500	39
Copper slags from Oker	108,000	65.4
Lead-matte slags	96,600	58.4
Slags from same smelting	92,400	56
Dust	2,250	1.3
Total materials	528,750	320.1
Coke used	68,400	41.5
Charcoal used	1,080	0.65
Products:		
Argentiferous lead	86,650	52.5
Lead-matte	102,650	62.8
Slag.		

	Ag.	Pb.	Cu.
Contents of the lead per cent	0.15		
Contents of the lead-matte	0.025 to 0.03	7 to 8	5.5
Contents of the slag	0.0007	0.46	

A comparison of the workings of the two furnaces shows that there is in reality very little difference in the consumption of fuel and the value of the products. The *proportion* of argentiferous lead to lead-matte produced is apparently more favorable in the round furnaces, but the proportion of lead-bearing materials to ore in the two charges is so different, and so favorable for the round furnace, that the comparative value of the above-mentioned figures becomes very doubtful in this respect; and, in fact, the only thing which in comparison with the round furnace can be brought against the Raschette is the greater difficulty of keeping the hearth clean on account of the depth from breast to breast.

The slag from this first smelting falling from an average charge of:

Ore	100
Roasted lead-matte	51
Oker copper-slag	60
Slags from same smelting	93
Dressed scrapings and *débris*	3
	307

Contains, according to an analysis by Hampe, (August, 1870:)

SiO_2	37.908	
BaO,So_3	1.508	
FeO	32.695	
FeS	1.823	0.663 S. 1.160 Fe.
Al_2O_3	8.320	
CaO	5.416	
MgO	1.302	
ZnO	3.948	
PbO	3.896	
MnO	1.020	
KO	0.419	
NaO	1.013	
NiO CoO	0.038	
Cu_2S	0.100	0.020 S. 0.080 Cu.
Ag	0.0007	
SbS_3	0.070	0.020 S. 0.030 Sb.
PO_5	0.708	
	100.1847	

There are in use at present eight round furnaces with four tuyeres (water-cooled) each. In three furnaces the tuyeres have at the mouth a diameter of 2½ inches, in the others 1¾. There is no perceptible difference in the running of the furnaces, though they are all worked under the same pressure of blast, *i. e.*, with eight to ten lines quicksilver. There is no important deviation in the dimensions of the furnaces built lately from those erected at first and described in my report for 1871. A fifth tuyere which it was thought advisable a short time ago to try in the breast, immediately above the slag-opening, has been discarded as unnecessary, and in some cases even detrimental.

There is furthermore one Raschette furnace with five tuyeres in each of the long sides and one in each short one. These tuyeres have a diameter of 1¾ inches at the mouth. The following are the dimensions of this furnance:

	Feet.	Inches.
Height from the furnace-floor to charge-floor	17	10
Height from charge-floor to upper edge of boshes	2	2
Height from furnace-floor to upper edge of boshes	20	
Height from furnace-floor to upper edge of hearth-plate	1	9
Height from furnace-floor to highest point of sole-stone		9
Height from furnace-floor to lower edge of water-trough	2	3
Height from furnace-floor to upper edge of stone, carrying arch over breast	6	11¼
Height from upper edge of hearth-plate to lowest tuyeres		14⅜
Height from upper edge of hearth-plate to next following		16
Height from upper edge of hearth-plate to the highest		17¾
Height from upper edge of hearth-plate to next following		16⅞
Height from upper edge of hearth-plate to next following		15⅜
Outer length of furnace just below charge-floor	11	6
Outer length of furnace just above charge-floor	9	9
Depth of furnace measured outside	10	4
Inside size of furnace at level of tuyeres	3 by 8	2
Inside size of furnace at upper edge of boshes	5 by 7	4
Horizontal distance of tuyeres from middle to middle	1	4

There is also one round furnace of the Pilz pattern with eight tuyeres of 1¾ inches diameter at the mouth, the dimensions of which are the following:

	Feet.	Inches.
Height from furnace floor to tuyeres	4	5¼
Height from furnace-floor to slag-spout	3	2¼
Height from furnace-floor to charge-floor	21	
Height from furnace-floor to charge-opening	23	
Height from furnace-floor to gas-flue	18	4⅝
Inside diameter from furnace-floor to a height of 2 feet 8¼ inches	4	5¼
Inside of diameter of furnace at level of charge-floor	6	5¼
Inside diameter of charge-funnel	5	
Distance of tuyeres from middle to middle	1	8¼
Height from furnace-floor to middle of circular blast-pipe	8	6

All the above furnaces are supplied with wind from the same horizontal cylinder-blast, (described in Kerl's Hüttenkunde,) but when they are all in blast at the same time, the present machinery is insufficient to furnish the wind required. It is therefore intended to erect another (vertical) blast-engine in the near future.

It appears from the above tables of charges that the percentage of coke to ore used is somewhat larger than usual; but it must be remarked here, that the coke at the disposal of the works is of inferior quality, containing usually from 14.5 to 19 per cent. of ashes and from 4.35 to 12.54 per cent. of moisture. During the month of May, 1873, all the coke received averaged rather better than usual, and contained, ashes, from 8.5 to 10.5 per cent.; moisture, from 2.77 to 7.06 per cent. Those coming from Osterholz are so far the best. They contain on an average 9.56 per cent. ashes and 2.7 per cent. moisture.

The argentiferous lead coming from the ore-smelting is not treated any further at the Clausthal Works, but goes to Lautenthal, to be there deprived of its silver by means of zinc, and to be refined. The lead-matte from the same smelting is treated further as follows:

It is thrown into large heaps, without breaking up the disks as taken from the tapping-basins, and left to be acted upon by the atmosphere for several months. At the end of this time the matte is in good shape for roasting, *i. e.*, it has cracked, is partly decomposed, and falls into small pieces upon handling. It is then thrown upon beds of wood in sheds, the heaps being very large. There is no definite limit to their size, except in height, which is from 6 to 7 feet. The width varies from 15 to 25 feet, and the length depends only upon the supply of material on hand. This first fire burns from four to six weeks, but accomplishes little in regard to the elimination of the sulphur. The matte is, however, now in excellent shape for good roasting. The second fire shows already portions which are sufficiently roasted, and which are taken away. Other parts of the heap, however, may have to go through from seven to thirteen fires, the progress in roasting depending very much upon the state of the atmosphere.

A late sample of lead-matte (April, 1873,) contained before roasting, according to an analysis by Dr. Fraatz:

Fe	54.73
Cu	5.90
Pb	13.02
Sb	0.18
Co	0.18
Ni	0.08
S	25.31
	99.40

The contents of two samples of lead-matte in copper and lead were, according to an analysis by Kühleman, in December, 1870:

No. 1, resulting from ore-smelting with Oker copper slags as principal flux:

Cu	5.5 per cent.
Pb	11.0 per cent.

No. 2, resulting from ore-smelting with lead-matte slags as principal flux:

Cu	4 per cent.
Pb	9 per cent.

Of the roasted lead-matte about two-thirds are added in the ore-smelting, in order to utilize the iron contained in it, for the fluxing of the silica and the removal of the sulphur from the lead and to extract a part of the lead from the matte. The remaining third is smelted in lots of 100 cwt., with 100 to 108 cwt. of unclean ore-slag, in low sump-furnaces, with open breast. These furnaces have only one tuyere, (not water-cooled,) and have the following dimensions:

	Feet.	Inches.
Height from hearth-plate to tuyere	1	2
Height from hearth-plate to top	6	6
Width of breast at level of hearth-plate	1	8
Width of breast 5 feet above hearth-plate	2	2
Width of back-wall at level of tuyere	1	4½
Width of middle of side wall at level of tuyere	1	6½
Inclination of tuyere wall: in 6 feet 6 inches from hearth-plate up		9
Depth of furnace	3	4
The lowest point of the sole-stone lies below the middle of tuyere	3	3

The result of this lead-matte smelting is argentiferous lead, first copper-matte and slag. The former is rich and goes directly to the cupelling-furnace, furnishing silver, rich skimmings, rich and poor litharge and hearth. The further treatment of the latter products may be followed in the scheme of Clausthal processes appended to this chapter. The second product (first copper-matte) is well roasted in four to five fires, and then again smelted in the low-furnace for rich argentiferous lead; second, copper-matte and rich slag. This lead also goes directly to the cupelling-furnace. The copper-matte is now taken out of the lead-processes and goes into the copper-smelting department. It is roasted again several times and then smelted with ore-slag and slag from the same process in shaft-furnaces, with closed breast and inclined bottom, from which the melted materials run continually, gathering and separating themselves, according to specific gravity, in basins outside of the furnace. (*Brillenofen.*) In this smelting there results already some argentiferous and plumbiferous black copper, which goes to the Altenau smelting-works into the copper-vitriol department, rich third copper-matte and rich slag, which latter goes partly back into the same process and partly into the ore-smelting. This process is repeated until all the copper is converted into black copper. Exact data, giving averages for the year 1870, may be seen in the scheme given below.

In this connection, the following analyses of slags resulting from the first and second lead-matte smeltings and of lead copper-mattes, resulting in these processes, are of great interest to the metallurgist:

Analysis by Hampe (1870) *of slag from the first lead-matte smelting, resulting from a charge of* 100 *ctr. roasted lead-matte to* 108 *ctr. ore-slag:*

SiO_2	30.579	
BaO,SO_3	1.229	
FeO	42.869	
$Fe\,S$	4.128	1.521 S. 2.607 Fe.
Al_2O_3	3.694	
CaO	4.893	
MgO	1.272	
ZnO	5.346	
PbO	2.048	
MnO	0.851	
KO	0.585	
NaO	1.311	
NiO CoO	0.033	
Cu_2S	0.359	0.072 S. 0.286 Cu.
Ag	0.0008	
SbS_3	0.083	0.023 S. 0.060 Sb.
PO_5	0.869	
	100.1478	

Slag resulting from the second lead-matte smelting from a charge of 100 *ctr. matte to* 108 *ctr. ore-slag—analysis by Hampe,* 1870.

SiO_2	30.704	
BaO,SO_3	1.032	
FeO	43.139	
FeS	1.839	0.679 S. 1.160 Fe.
Al_2O_3	7.552	
CaO	3.755	
MgO	1.313	
ZnO	4.467	
PbO	1.723	
MnO	0.870	
KO	0.833	
NaO	1.364	

NiO CoO	0.118	
Cu_2S	0.486	0.098 S. 0.388 Cu.
Ag	0.0008	
SbS_3	0.101	0.028 S. 0.073 Sb.
PO_5	0.743	
	100.0398	

Results of analyses by Hampe, March, 1871, of four samples of matte.

	I.	II.	III.	IV.
	Lead-matte from ore-smelting, the charge was: ore 100, roasted lead-matte 51, copper-slag 60, ore-slag 93, dressed scraps 3 parts.	Same matte after roasting.	Matte from first lead-matte smelting, the charge being 100 matte to 108 parts ore-slag.	Copper-matte from second lead-matte smelting, the charge being 100 matte to 108 parts ore-slag.
Pb	10.655	10.492	7.758	8.148
Cu	4.620	4.123	12.502	21.596
Sb	0.267	0.128	0.979	0.419
Ag	0.0239	0.0327	0.0351	0.058
Fe	53.112	52.411	48.972	40.955
Zn	2.110	2.459	1.923	1.893
Mn	0.385	0.317	0.282	0.220
Co	0.215	0.239	0.328	0.376
Ni	0.097	0.111	0.148	0.110
$Si O_3$	0.510	1.486	0.411	0.195
Ca	0.383	0.336	0.303	0.346
Mg	0.054	0.061	0.037	0.049
S	26.877	0.613	25.795	24.928
$S O_3$		4.225		
O		22.9663		
Total	99.3149	100.0000	99.4731	99.3537

In cupelling the argentiferous lead resulting from the first and second lead-matte smelting, (the latter sometimes called first copper-matte smelting,) two kinds of litharge are produced. The poor kind from the first part of the process is directly sold; the rich litharge is further treated and occasions a number of subsequent processes.

It is first partially reduced in a reverberatory, the results being lead with 0.01 to 0.015 per cent. Ag; *Abstrich* (mostly oxide of lead) and copper scum. The first is deprived of its silver by means of zinc, which is added in four parts. The results are: 1, refined lead with 0.0005 per cent. Ag, which is sold; 2, *Abzug*, (copper-lead scum,) which is added in the lead-matte smelting; 3, rich zinc-crust, with 0.075 per cent. Ag, which is added in the lead-matte smelting; and 4, oxides of lead, antimony, zinc, &c., which are further treated in a reverberatory. From the latter result: 1, poor lead, which is refined; 2, skimmings, with 68 per cent. lead, which are liquated in a reverberatory; 3, residues from the liquation, which are added in the lead-matte smelting. From the refining and poling of the poor lead, result: 1, lead, which is sold; 2, antimonial lead-skimmings; 3, hearth; 4, scums. The antimonial skimmings are liquated and the result is: 1, lead, with 0.03 per cent. Ag, which is added in the cupellation; 2, *Abstrich* residues; 3, skimmings, formed on the lead after leaving the furnace, which go into the lead-matte smelting. The residue remaining after liquation is smelted together with copper-matte slag in the round furnace, and furnishes hard lead with 0.0012 per cent. Ag, which is sold, bringing one thaler (72 cents) more per ctr. than refined lead, and slags with 2.38 per cent.

Pb and Sb, which are added in the lead-matte smelting. The hard lead contains, according to an analysis by Schollmeyer, August, 1871:

Cu	0.780
Sb	12.292
Zn	traces.
Fe	
Ag	

Poor litharge, which is sold as such, contains, according to the same authority:

Cu	0.2153
Sb	0.0109
Fe	0.0103
Zn	0.0229
Ag	trace.

As will be seen from the foregoing account, the Clausthal Works do not, at present, desilverize by the zinc process all their product of argentiferous lead. The lead obtained in the first and second matte-smelting is cupelled; the resulting litharge is again reduced, and only the product of this final reduction is desilverized by means of zinc at Clausthal. The great mass of the argentiferous lead from the ore-smelting goes to the desilverization-works at Lautenthal, and the rich lead from the lead-matte-smelting is directly cupelled at Clausthal. This latter lead was, however, at one time also desilvered by means of zinc and then refined. The following analyses by Hampe, October, 1872, show the composition of such lead in the various stages of the process:

I. *Analysis of the first argentiferous lead from lead-matte-smelting.* II. *The same after taking off first scum ("Schlicker,") after melting down in the kettle.* III. *The same after further oxidation and poling.* IV. *The same after depriving it of its Ag by means of Zn and removing the abstrich, by poling.* V. *Litharge produced from lead* IV *for the market.*

	I.	II.	III.	IV.	V.
Bi	0.00301	0.00270	0.00260	0.00268	......
Cu	0.50200	0.49120	0.40070	0.00280	0.009
Sb	0.82780	0.73210	0.60300	0.16427	0.005
Fe	0.00180	0.00287	0.00210	0.00538	....
Zn	0.00120	0.00120	0.00120	0.00075	....
Ni	0.00504	0.00392	0.00450	Trace....	....
Ag	0.35300	0.31300	0.33100	0.00950	0.00125
Cd As	Trace....	....	....	....	....
Pb	98.30615	98.54311	98.5049	99.81462	....
Total	100	100	100	100	....

The lead resulting as merchandise was not pure enough for the requirements of the trade. For this reason the lead resulting from the lead-matte-smelting is now directly cupelled, and from the litharge produced a much purer lead is made. I was promised the analysis of the marketable lead as produced at present, but up to the time of this writing it has not reached me. The product of Clausthal does, however, not vary much in composition from that of Altenau, an analysis of which is given below, under another head.

From the great mass of the Clausthal argentiferous lead, which is desilverized by means of zinc at Lautenthal, is made a marketable lead, refined by the use of steam, which contains, according to a late analysis of Dr. Hampe:

Pb (calculated)	99.983573
Bi	0.008498
Cu	0.000954
Sb	0.001184
Ag	0.000500
Fe	0.004930
Zn	0.000361
Ni Cd	trace.
	100

In 1870 lead refined at the same works contained, according to Schollmeyer:

Pb	99.983139
Cu	.001413
Sb	.005698
As	......
Bi	.005487
Ag	.000460
Fe	.002289
Zn	.000834
Ni	.000680
	100

The rich foreign silver ores coming to the works at present are smelted in separate campaigns (without mixing them with the common mixture of home ores) in order to extract their value in a short time. This is done by avoiding the formation of the many intermediate products resulting in the common smelting process. In the summer of 1873 there were principally ores from Chili at the works, one portion of which carried the silver in the form of chloride, in a very quartzose limestone, (50 per cent. SiO_2;) the other portion carried some 4 per cent. of lead, a considerable admixture of zinc-blende, and a gangue of quartz.

A charge was composed as follows:

Foreign ores (obtained through Meier of Bremen),	10 ctr.,	(4 per cent. Pb, 1.5 per cent. Ag in quartz and blende.)
Chili ores (from Robertson of Hamburg)	40 ctr.,	(3 to 4 per cent. Pb, 1 per cent. Ag in quartz and limestone.)
Home ores, from the "Iberg,"	2 ctr.,	(4 per cent. Pb, 0.1 per cent. Ag, with spathic iron and lime.
Litharge	30 ctr.	
Oker copper-slag	30 ctr.	
Lead-matte slag	60 ctr.	
Slag from same process	10 ctr.	
	182 ctr.	

Products:

Argentiferous lead	30 ctr.
Lead-copper matte	18 ctr.

This lead contains 1.5 per cent. Ag.

The matte contains 0.10 per cent. Ag, 8 per. cent. Pb.

The slag contains 0.0075 Ag, 1 per cent. Pb.

One and a half ctr. of coke were used for 15 troughs at 70 pounds = 1,050 pounds charge.

The following are the average lengths of campaigns, quantities smelted in twenty-four hours, and time of smelting 100 ctr. ore for the round Kast, the Raschette, and the Pilz furnace, respectively, as taken from the records of the years 1870, 1871, and 1872:

Lengths of campaigns:

Round furnace, 4 tuyeres	Average, 51 weeks, 3 days. Shortest campaign, 16 weeks. Longest campaign, 113 weeks.
Round furnace, 8 tuyeres	Average, (14)* 19 weeks. Shortest campaign, (4) 12 weeks. Longest campaign, 24 weeks.
Raschette	Average 15 weeks. Shortest campaign, 5 weeks. Longest campaign, 30 weeks.

Quantities of ore in charge smelted in twenty-four hours:

Round furnace, 4 tuyeres	70 ctr.
Round furnace, 8 tuyeres	92.5 ctr.
Raschette, 12 tuyeres	104.6 ctr.

Time of smelting 100 ctr. ore in charge:

Round furnace, 4 tuyeres	34.16 hours.
Round furnace, 8 tuyeres	25.92 hours.
Raschette	22.92 hours.

The following represents the work done at the Frankenscharn Works during the year 1872:

A.—*Ore-smelting.*

Total number of 12-hour shifts, 6,220.
Wages per shift, 27 silbergroschen, equivalent to $0.648.

Ore smelted	9,300,000	kilograms.
Matte smelted	4,966,350	"
Oker copper slags	5,843,000	"
Home copper slag	191,400	"
Lead-matte slag	2,623,800	"
Ore-slag	6,271,450	"
Rich litharge	19,800	"
Salamanders	9,550	"
Dressed-furnace residues	57,000	"
Made and used dust	127,250	"
Made and used accretions	64,600	"
Hearth from cupelling-furnace	23,700	"
Total charge	29,497,400	"
Product:		
Argentiferous lead	5,425,700	"
Argentiferous lead-matte	6,388,800	"
Fuel used:		
Coke	4,434,225	"
Charcoal	106,530	"
Stone-coal	13,817.5	"

(1 kilogram charge to 6.47 charge.)
(For 100 ctr. ore = 3.34 12-hour shifts.)

Materials used, products, and fuel consumed, calculated for 100 *ctr. ore.*

Material:

Ore	100
Matte	53.40
Oker copper slag	62.83
Home copper slag	2.06
Lead-matte slag	28.21
Ore-slag	67.43
Rich litharge	0.21
Salamanders	0.1
Dressed-furnace residues	0.61
Dust	1.36
Accretions	0.69
Hearth	0.25

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* The figures in ( ) include the first short trial campaign of four weeks, which fairly ought to be omitted from the calculation.

Products:

Argentiferous lead	58.34
Lead-matte	68.69

Fuel:

Coke	47.68
Charcoal	1.14
Stone-coal	0.14

B.—*Roasting.*

a. Lead-matte, used after roasting in ore-smelting and lead-matte smelting	47,940,000 kilograms.
Fuel used:	
Wood	731 cubic meters.
Faggots	207,481 pieces.
b. Copper-matte, used after working in copper-smelting	3,646,000 kilograms.
Fuel used:	
Wood	69 cubic meters.
Faggots	12,654 pieces.

C.—*Lead-matte smelting.*

Aggregate number of 12-hour shifts	1,130	
Materials:		
Matte smelted	1,746,250	kilograms.
Ore-slag	1,885,950	"
Products:		
Argentiferous lead	127,000	"
Copper-matte	414,700	"
Fuel:		
Coke used	440,600	"
Charcoal	21,810	"

Calculated for 100 parts matte this shows:

Matte	100
Slag	108
Argentiferous lead	7.25
Copper-matte	23.8
Coke used	25
Charcoal	1.20

D.—*Copper-matte smelting.*

(Quantities given in kilograms.)

Aggregate of—	12-hour shifts.	Matte smelted.	Copper-slag.	Ore-slag.	Argentiferous lead.	Black copper.	Copper-matte.	Coke used.	Charcoal used.
First smelting	176	311,250	....	291,600	13,550	....	113,700	64,800	1,960
Second smelting	148	191,300	185,400	....	....	14,950	94,850	78,450	2,610
Third smelting	76	92,850	96,200	....	....	22,200	43,600	29,710	1,140
Fourth smelting	37	43,600	44,400	....	....	8,000	24,250	11,690	660
Fifth smelting	20	31,900	24,700	....	....	5,850	14,100	11,000	450
Sixth smelting	12	14,100	14,300	....	....	1,700	8,200	6,100	90
Total	469	685,200	365,000	291,600	13,550	52,700	298,700	201,750	6,910

E.—*Cupellation of argentiferous lead from lead-matte smelting.*

Material:		
Argentiferous lead	149,250	kilograms.
Products:		
Silver	386.95	"
Poor litharge	61,700	"
Rich litharge	66,750	"
Abstrich (antimonial scum or black litharge)	7,350	"
Hearth	19,500	"
Fuel and hearth material:		
Stone-coal	15,867	"
Faggots*	240	pieces.
Marl	20,550	kilograms.

F.—*Desilverization of the argentiferous lead reduced from the rich litharge of the last process.*

Aggregate number of shifts of skimmers		22	
Aggregate number of shifts of firemen		11	
Argentiferous lead	25,000	50,000	kilograms.
Rich lead (from lead-matte smelting)	25,000		
Products:			
Rich zinc-crust (exclusive of 4,112 kilograms, which remain in the middle kettle to go into next year's work)		4,896.5	"
Poor zinc-crust		1,206	"
Oxides from refining (first period)		4,300	"
Oxides from poling (last period)		1,505	"
Abzug (first scum, formed in melting the lead)		5,525	"
Refined lead		29,245	"
Zinc used		633	"
Stone-coal used		6,550	"
Faggots used		45	pieces.

G.—*Liquation of lead Krätze*† *in the reverberatory.*

Charged	4,500	kilograms.
Products:		
Poor lead	2,800	"
Liquation residues (krätze)	200	"
Abstrich	1,100	"
Fuel:		
Stone-coal	600	"
Faggots	30	pieces.

H.—*Reduction of litharge in the reverberatory.*

Litharge charged	76,500	kilograms.
Products:		
Rich lead	57,650	"
Abstrich	14,500	"
Cupriferous skimmings (*Krätze*)	2,650	"
Fuel:		
Stone-coal	9,150	"
Faggots	780	"

I.—*Refining of matte-lead, liquation-lead from "Abstrich," &c., in reverberatory.*

Lead charged	20,000	kilograms.

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[*] One thousand faggots are equal in effect to 34¼ ctr. of bituminous coal.

[†] *Krätze* is the name given to a mixture of oxides of lead, (principally,) copper, and other metals in smaller quantity, which may either be the residue remaining in liquation or the scum formed on the lead in the tapping-basins; only an impure lead can be produced from it. A very cupriferous first scum is in some works called *schlicker*.

SCHEME OF THE CLAUSTHAL SILVER-SMELTING

[Arranged according to the results of the year 1870.]

[Final products printed in small caps; foreign terms, in italics; the German centner (ctr.) here referred to is 50 kilo

1. Ore; 100 ctr., containing 0.09 to 0.1 per cent. of silver and 60 to 62 per cent. of lead, are smelted with 50 to 60 ctr. roasted lead matte, 70 ctr. Oker copper-slag, 80 ctr. ore-slag, 2.91 ctr. dust, 0.91 ctr. dressed furnace-scrap, and 0.28 ctr. old cupel-bottoms.

2. ARGENTIFEROUS LEAD, 58.68 ctr., containing 0.14 to 0.15 per cent. silver. (Goes to Lautenthal to be desilverized by means of zinc. See scheme of Lautenthal process elsewhere in this report.)

3. Lead-matte, 73.17 ctr., containing 0.025 to 0.03 per cent. silver, 7 to 8 per cent. lead, and 4 to 5 per cent. copper. (Roasted; 50 to 60 ctr. returned to No. 1; the rest is smelted by itself in low shaft-furnaces; 100 ctr. roasted lead-matte with 100 to 108 ctr. uncleaned ore-slag.—"Lead-matte smelting.")

4. Unclean slag,* containing 0.0006 to 0.0007 per cent. silver and 0.56 to 0.75 per cent. lead. (All added in No. 3.)

5. Clean slag,* (partly returned to No. 1 and partly thrown on the slag-dump.)

6. Argentiferous lead; 9 ctr., containing 0.2651 per cent. silver, (cupelled in charges of 180 ctr.)

7. First copper-matte, also called "second lead-matte;" 35.72 ctr., containing 0.0457 per cent. silver, 8.18 per cent. lead, 12.96 per cent. copper. (Roasted and smelted in charges of 100 ctr. in low shaft-furnaces.)

8. Slag, 161 ctr., containing 0.00048 per cent. silver, 0.54 per cent. lead, and a trace of copper. (Partly returned to No. 1 and partly thrown on the slag-dump.)

9. Argentiferous lead, 3.03 ctr., containing 0.3658 per cent. of silver. (Is cupelled.)

10. Second copper-matte, 48.97 ctr., containing 0.0612 per cent. silver, 8.66 per cent. of lead, and 28.9 per cent. of copper. (Roasted and smelted in *Brillenöfen*, in charges of 100 ctr.)

11. Slag, 153 ctr., containing 0.0005 per cent. silver, 0.5 per cent. lead, and trace copper. (Partly to No. 7 and partly to No. 1.)

12. BLACK COPPER, 8 ctr. (Goes to the copper-vitriol works at Altenau, to be desilverized.)

13. Third copper-matte, 48.54 ctr., containing 0.0879 per cent. silver, 58.71 per cent. copper. (Roasted and smelted in *Brillenöfen*, in charges of 100 ctr.)

14. Slag, 196 ctr., containing 0.0009 per cent. silver, 0.791 per cent. lead, and trace copper. (Partly to No. 10 and partly to No. 1.)

15. BLACK COPPER, 12.21 ctr. (Goes to the copper-vitriol works at Altenau to be desilverized.

16. Fourth copper-matte, 44.82 ctr. (Goes into next year's work.)

17. Slag, 195 ctr., containing 0.0015 per cent. silver and 0.8 per cent. copper. (Returned to No. 1.)

18. SILVER, 47.7 lbs. (To the Lautenthal Works to be refined.)

19. Rich litharge,† containing 0.0012 to 0.0025 per cent. silver and 91 per cent. lead. (Reduced in reverberatories in charges of 90 ctr.)

20. POOR LITHARGE.† (Packed in barrels and sold.)

21. *Abstrich*, 20 ctr., containing 0.0012 per cent. silver and 86 per cent. of lead and antimony. (Liquated in reverberatory in charges of 90 ctr.)

22. Cupel-bottom, 25 ctr., containing 0.025 per cent. of silver and 6.6 per cent. lead. (Returned to No. 1.)

23. Rich lead, 70 ctr., containing 0.01 to 0.015 per cent. silver. (Is desilverized by means of zinc in charges of 250 ctr.; zinc added in 4 portions of 40, 100, 60, 50 pounds.)

24. *Abstrich*, 16 ctr., containing trace of silver and 65 per cent. of lead and antimony. (Is liquated in reverberatory.)

25. Copper-skimmings, (*Krätze*,) 4 ctr., with trace of silver. (Returned to No. 7 or No. 10.)

*Nos. 4 and 5 amount to 174 ctr.

USTHAL SILVER-SMELTING WORKS.

ged according to the results of the year 1870.]

n terms, in italics; the German centner (ctr.) here referred to is 50 kilorams, nearly.]

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23. Rich lead, 70 ctr., containing 0.01 to 0.015 per cent. silver. (Is desilverized by means of zinc in charges of 250 ctr.; zinc added in 4 portions of 40, 100, 60, 50 pounds.)

24. *Abstrich*, 16 ctr., containing trace of silver and 65 per cent. of lead and antimony. (Is liquated in reverberatory.)

25. Copper-skimmings, (*Krätze*,) 4 ctr., with trace of silver. (Returned to No. 7 or No. 10.)

26. REFINED LEAD, 177.21 ctr., containing 0.0005 per cent. silver. (Goes into the trade.)

27. Cupriferous skimmings, (*Schlicker*,) containing 0.001 per cent. silver and 98 per cent. of lead. (To No. 3.)

28. Rich zinc-crust, 16.55 ctr., containing 0.075 per cent. silver. (Added in No. 3.)

29. Lead-skimmings, (*Blei Krätze*,) 30.75 ctr., containing trace of silver and 91 per cent. of lead. (Liquated in reverberatory in charges of 90 ctr.)

30. Poor lead, 70 ctr., containing 0.001 per cent. silver. (Refined in reverberatory in charges of 200 ctr.)

31. *Abstrich*, 16 ctr., containing 68 per cent. lead. (Liquated in reverberatory.)

32. Liquated residues, 4 ctr. (Returned to No. 3.)

33. SECOND QUALITY PIG-LEAD, (*Muldenblei*,) 159 ctr., containing 0.001 per cent. silver. (Goes into the trade.)

34. *Abstrich*, 17 ctr., containing 88 per cent. of lead and antimony. (Liquated in charges of 90 ctr., in reverberatory.)

35. Bottom, 1 ctr., containing 60 per cent. lead. (To No. 1.)

36. Lead-skimmings, (*Blei Krätze*,) 24 ctr., containing trace of silver and 90 per cent. lead. (Liquated in reverberatory.)

37. *Abstrich* pig-lead, 31 ctr., containing 0.03 per cent. silver. (Cupelled.)

38. Liquation residue of *abstrich*, 57 ctr., containing 64 per cent. of lead and antimony. (Reduced with copper-matte slag in the round furnaces, 100 ctr., "Abstrich," with 50 ctr. slag.)

39. Metal-skimmings, (*Saiger Krätze*,) 3 ctr., (To No. 3.)

40. HARD LEAD, 72 ctr., containing 0.0012 per cent. silver. (Goes into the trade.)

41. Slag, 73 ctr., containing 2.38 per cent. of lead and antimony. (To No. 3.)

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† Nos. 19 and 20 amount to 146 ctr

Products:

255 pigs, at 140 pounds	17,850	kilograms.
Abstrich	1,000	"
Lead-Krätze	1,550	"
Hearth	100	"

Fuel:

Stone-coal	900	"
Faggots	30	pieces.
Marl used for hearth	1,486	kilograms.

K.—*Liquation of Abstrich.*

Abstrich charged	13,500	kilograms.

Products:

Lead	4,350	"	
Liquation *Krätze*	200	kilograms	(to lead-matte smelting.)
Liquation residues	8,350	"	(is reduced to hard lead.)

Fuel:

Stone-coal	2,050	kilograms.
Faggots	140	pieces.

L.—*Manufacture of building-stone from ore-slag.*

36,655 PIECES.

(100 pieces No. 4 (12 × 6 × 6 inches) are sold for 20 silbergroschen, or $0.48.)

II.—THE SAINT ANDREASBERG WORKS.

The bulk of the ores treated at these smelting-works for years past has been of foreign origin, while the mines of the immediate vicinity have furnished only a small quantity of mostly exceptionally rich silver ores. These mines, of which the celebrated "Samson" is the most widely known, on account of its eminence as the deepest silver mine in Europe, carrying at the same time enormously rich and finely crystallized ores, have all reached such a depth that mining has become expensive and not very profitable, especially as the pockets of rich ore in the veins do not occur frequently.

At present, since the smelting-works of the Harz, Freiberg, and Mansfeld have formed a coalition for the purchase of foreign ores, which permits a distribution of these ores as suited to the various processes at the different works, and acts also very beneficially as far as competition in the ore market of foreign, especially English, smelting-works is concerned, the Andreasberg furnaces are kept busy continually; while formerly frequent interruptions could not be avoided.

In the summer of 1873 the works treated the following ores:

A.—Ores from the Andreasberg mines, "Samson" and "Neufang," which consist of two classes:

1. Lead-ores, with about 30 per cent. of lead and 0.1 to 0.75 per cent. silver. These come to the works from the dressing-works in a pulverized state.

2. Rich silver-ores proper, with a trace to 15 per cent. of lead (average 5 per cent.) and 2 to 30 per cent. of silver. These are all antimonial silver-ores, and are furnished to the works in small quantities, as they are found from time to time in the mines.

B.—Foreign ores, which contain on an average 1 per cent. of silver. About half of these are "dry ores," *i. e.*, ores containing no appreciable amount of lead, and half pyritous ores, which mostly contain gold and, on average, 10 per cent. of lead. The gangue of the foreign ores is mainly siliceous.

All the pyritous ores are prepared for smelting by roasting them once in shaft roasting-furnaces. These are 10 feet high, have a rectangular section of 5 by 4 feet, and a bottom which is inclined both ways from a central ridge ⊔ in order to facilitate the discharge of the roasted ore.

The quartzose dry ores are burned when in the form of pieces, for the purpose of making them more porous. Ores containing lead and zinc-blende in considerable quantity have so far not been roasted; but it is intended to do so in the future. For this purpose a reverberatory is to be constructed, about 45 feet in length and 6 feet 2 inches wide in the clear. There are to be six working doors on each of the long sides, and two fire-grates for bituminous coal. The furnace is to be connected with extensive condensation-chambers, in order to save the large quantities of lead and silver, which would otherwise be lost.

The smelting is conducted in Raschette and round furnaces of the same construction as those at Clausthal. The round furnaces are preferred, and will probably be alone used in the future.

An average charge, at the time of my visit, was as follows:

Foreign ores	100
Copper-slag from Oker	100
Slag from matte-smelting and from the same process	100
Litharge (for ores containing 1 per cent. of silver)	75
	375

The proportion of coke used to charge smelted is 1:7.25. The round furnace smelts in twenty-four hours from 6.5 to 7 tons of charge.

The quantity of litharge added to the charge is dependent on two considerations:

1. It is so proportioned as to permit the production of a certain absolute weight of pig-lead; as, for instance, in the Raschette from 100 cwt. of charge a production of at least 25 to 30 cwt. of lead.

2. The silver contents of the lead, in proportion to that of the ore charged, must be within the limits of the proportion established as the most advantageous by the experience of the works. For ores containing below 1 per cent. of silver, the contents of silver in the lead is to be from 0.5 to 0.75 per cent.; for ores containing 1 per cent. of silver and above, the lead produced is to contain from 1 to 3 per cent.

These rules have been adhered to for a long time, but have varied slightly according to the necessities at the works. The quantities of litharge added to the charge were thus, in 1871, according to Wedding, so regulated that with ores in the charge of 0.2 per cent. to 0.5 per cent. silver, lead of about 0.5 per cent. silver; of 0.5 per cent. to 1.0 per cent. silver, lead of about 1.0 per cent. silver; of more than 1.0 per cent. silver, lead of about 1.2 per cent. silver was desired as the result of the smelting. The interesting fact was here remarked that gold enters the slag and matte in proportionally smaller quantity than the silver. The resulting lead-matte and slag were satisfactorily poor in silver.

During the year 1873 the products resulting from the ore-smelting were—

1. Lead, with 0.5 to 3 per cent. silver.

2. Lead-matte, with 0.07 to 0.35 per cent. silver and varying contents of copper.

3. Rich slag, that is, the slag gathered from the basins after tapping in ordinary campaigns, and the whole of the slag in campaigns when ores containing from 2.5 to 3 per cent. of silver are smelted. This is smelted with rich old slags from the extensive dumps around the works, in separate "slag-smeltings."

4. Poor slag, which must not contain above 2 per cent. of lead and 0.002 per cent. silver. The contents of silica in the slag varies greatly, but may be set down for the general run of campaigns as 35 to 38 per cent.

Two analyses given by Wedding, in his "Experiments and Improvements at the Government Metal Smelting Works during 1871," show the principal constituents of the slag then made. Newer analyses were not on hand at the time of my visit to the works, and the proportion in the slag made at that time, of SiO_2 to the bases, was not supposed to vary greatly from that herewith recorded.

	a.	*b.*
FeO	13.7	24.7
SiO_2	42.5	40.9
Al_2O_3	19.5	15.3
CaO	12.6	8.8
MgO	7.1	6.6
Cu_2O	...	0.27
PbO	1.2	1.25
Ag	0.0025	0.0030

The lead resulting from the ore-smelting is directly cupelled at the works. The silver produced is sent to the Lautenthal Works for refining, and the litharge is used in the ore-smelting.

The lead-matte is roasted once in the shaft roasting-furnaces above mentioned. Their capacity is 40 centner in 24 hours, and the sulphur contents of the matte are during this time brought down from about 24 to 5 per cent. The roasted lead-matte has lately been mostly added directly in the ore-smelting, where it forms a very desirable flux, rich in iron oxide. This is done over and over again, until the copper contents of the matte reach 10 to 15 per cent., when it goes into the copper-smelting. Here it is concentrated in three successive smeltings, when it is finally turned into black copper, which is sent to the Altenau Vitriol Works to be desilverized.

The Andreasberg lead-matte contains considerable quantities of antimony and arsenic.

Formerly, and as late as 1871, the Andreasberg lead-matte was treated, after roasting, in a separate smelting. According to Dr. Wedding, in the article above mentioned, the composition of a charge was as follows:

Lead-matte	100
Materials rich in lead, such as dressed furnace-residues, Krätze, hearth, &c	38
Slag	170

Proportion of coke used to charge smelted, 1:7.7.

Amount of charge smelted in twenty-four hours, in small furnaces with one tuyere, from 6 to 6.25 tons.

The slag resulting had the following composition:

FeO	38.50
SiO_2	30.15
Al_2O_3	15.90
CaO	10.03
MgO	1.05
Cu_2O	0.50
PbO	3.55
Ag	0.003
	99.683

The dust collected in the condensation-chambers from the roasting of ore and matte is rich in arsenic, and contains 0.006 per cent. silver and 4.2 to 6.6 per cent. lead. It is roasted for the purpose of first collecting the "arsenic flour," (impure arsenious acid,) which is then further treated for the production of "arsenic glass," (arsenious acid refined, as far as this is usually done at metallurgical works,) and then smelting the residue, which is mostly added in the slag-smelting, on account of its impurities.

All the rich slag made at Andreasberg is separately smelted, together with old slag from the dumps, furnace, and other residues rich in lead; poor ores rich in lead, and sometimes, but rarely, with an addition of copper-slag from Oker. An impure lead is the result. The composition of the slag resulting from this smelting is given by Dr. Wedding:

SiO_2	47.75
FeO	18.90
Al_2O_3	21.20
CaO	6.00
MgO	2.90
PbO	2.25
Ag	0.001
As & Sb	trace
	99.001

The comparative richness of this slag in lead and silver is due to the scarcity of cheap basic fluxes.

The lead from this process contains from 0.10 to 0.50 per cent. of silver, and is desilverized, by means of zinc, at the works. The zinc-crust is liquated; the liquation-lead is added in cupellation, and the zinc-dust in the ore-smelting, separate treatment not being advisable, as the whole quantity produced per annum does not exceed a couple of centner. The lead is refined by poling, and the *Abstrich* produced in the operation is reduced to hard lead, which at present brings a better price than refined lead.

The slag resulting in the slag-smelting is partly used for the manufacture of building-stone. For that purpose it must be tough and at the same time plastic. The contents of silica ought to be between 40 and 43 per cent., but the relative proportions of the bases are also of great importance. The slag ought not to be tapped into the molds, but must be put in by means of suitable tools, in small portions, which are spread horizontally over the whole mold, and cement to each other easily. If the slag is permitted to run into the molds, filling them at once, the stones become full of cavities and worthless for use.

During the summer of 1873 about 150 centner of rich ore were smelted daily, and it was intended to continue at that rate throughout the year, so that the works were expected to produce about 30,000 pounds of silver, a product never reached before.

Before closing this article, I wish to mention here the interesting facts noted at the Andreasberg Works since they have smelted so much American ore, in regard to the proportion of gold to silver obtained in the various stages of the process. The statement is taken from the article of Dr. Wedding above mentioned.

Gold in the silver obtained directly	0.887 per cent.
Gold in the silver obtained in the first matte-smelting	0.140 per cent.
Gold in the silver obtained by assaying slag	0.277 per cent.
Gold in the silver obtained from fumes	0.300 per cent.

Dr. Wedding says it is remarkable that in the products obtained formerly from Andreasberg ores these proportions were relatively reversed, viz:

Gold in the silver obtained directly	0.018–0.010 per cent.
Gold in the silver obtained in matte-smelting	0.070–0.024 per cent.
Gold in the silver obtained from slag	0.10 per cent.

and thinks that the reason for this is to be sought in the finer distribution of the gold in the Andreasberg than in the American ores. This explanation, I think, is not satisfactory. The true reason is probably to be found in the greater percentage of arsenic in the Andreasberg ores, which would actually carry a larger relative proportion of gold into matte and speiss than into the lead. The same behavior has been remarked in the smelting-works of Eureka, Nev., as pointed out by me on former occasions.

III.—THE ALTENAU WORKS.

At the Altenau Smelting-Works the following ores are treated:

1. Dressed lead-ores from the Upper Harz, which contain the amounts of lead and silver given above, in the account of the Clausthal Works, and in almost all cases a little copper. But the contents of copper, unless exceeding 3 per cent., do not enter the accounts.

2. Rich foreign silver-ores, principally from Mexico and the United States. The contents of these in lead and silver are very variable; but the silver contents exceed in many cases 1 per cent., while the percentage of lead is mostly low.

3. All the copper-ores obtained in the silver-lead mines of the Upper Harz. These consist almost entirely of copper pyrites, and contain too little silver to render its extraction profitable. They are treated by means of the common German copper-smelting process and the copper is sold as "rosette-copper," containing from 0.005 to 0.017 per cent. of silver.

Lead-smelting.—The lead and silver ores have heretofore been smelted, without a preparatory roasting, by means of the precipitation process in shaft-furnaces; but it is intended to roast them first in reverberatories hereafter.

The smelting takes place in Raschette and round (Kast) furnaces. It is intended to use in the future only the round furnaces.

A normal smelting-mixture is composed of:

	Amount in a charge.	Parts.
	Kilograms.	
Lead ores from the Upper Harz	1,500	100
Foreign silver-ores	1,000	66.66
Litharge	750	50
Copper-slag from Oker	1,500	100
Slag from ore-smelting at the works	1,000	66.66
Slag from lead and copper matte smelting	2,500	166.66
	8,250	550

This mixture is, however, by no means constant; it is always intended so be so regulated that a lead containing not over 1 per cent. of silver results.

The copper-slag from Oker contains about 1.5 per cent. of copper and trace of silver and gold.

From the above smelting result:

Lead, containing 0.9 to 1.0 per cent. silver.
Lead-matte, containing 0.14 to 0.18 per cent. silver.
Lead-matte, containing about 10 per cent. lead.
Lead-matte, containing from 8 to 12 per cent. copper.
Slag, containing 0.003 silver and 0.75 to 1 per cent. lead.

The lead goes directly to the cupelling furnace. The resulting cupreous scum is added in the matte-smelting; the litharge is nearly all used again in the ore-smelting; the silver is shipped to Lautenthal to be refined. Whenever a considerable quantity of litharge, over and above what is needed in the ore-smelting, has accumulated at the works, it is separately smelted, together with poor lead-ores. The litharge contains originally from 0.01 to 0.02 per cent. silver; the lead resulting from the treatment with poor lead-ores contains rarely above 0.3 per cent. of silver, and is desilverized by means of zinc. In melting this lead down for the purpose of desilverization, a scum is formed, (*Schlicker*,) which consists of PbS, CuS, and metallic lead. This is liquated in the cupelling furnace, and the resulting lead goes back into the desilverizing kettle; the dry scum remaining is added in the main lead-matte smelting.

The desilverization of the lead by means of zinc is conducted like the same process at Lautenthal, (of which see description in the chapter of this report devoted to that subject,) with the exception only that the lead is not refined by means of steam, but by poling. The argentiferous zinc-scum is smelted with basic slags in low-shaft furnaces, the resulting products being rich lead, which is cupelled, and slag, which contains some silver, and is therefore used again in the ore-smelting. The zinc of the zinc-scum is partly volatilized and partly goes into the slag.

Hard-lead (lead containing a considerable amount of antimony and other subordinate impurities) is made from the antimonial *Abstrich*, which results during cupellation of the rich lead, and from that produced during the refining of the lead resulting from the smelting of poor lead-ore with litharge.

All the rich slags are added either in the ore-smelting or the lead-matte smelting. The slag resulting from the smelting of poor lead-ores is thrown on the dumps.

The following is an analysis of the refined lead produced at Altenau by means of poling, from lead obtained in the treatment of rich foreign silver-ores together with the dressed lead-ores of the Upper Harz. It was made by Professor Hampe, at the Clausthal laboratory, in December, 1871, and has, so far as I am aware, not been published:

Bi	0.009580	Fe	0.003272
Cu	0.002475	Zn	0.000140
Sb	0.005743	Ni	0.000196
As		Pb	99.976719
Cl	0.000875		
Ag	0.00100		100

Other and earlier analyses of products and educts of the Altenau lead-process have been published from time to time in the various articles written on the subject and published in the Preussische Zeitschrift für Berg-Hütten und Salinenwesen, in the Berg-und-Hüttenmännische Zeitung, and other technical publications, to which the reader is referred. New ones, except that above given, did not exist at the works at the time of my visit in the summer of 1873.

Lead-matte smelting.—The lead-matte resulting in the lead-smelting, the contents of which are given above, is now all roasted in shaft-roasting furnaces 3 to 3½ meters high and 1.17 by 1.46 meters wide. In these it loses its sulphur to within about 7 per cent. These roasting-furnaces furnish the sulphurous acid for a system of sulphuric-acid chambers, which produce about 7,000 centner of sulphuric acid of 50° Beaumé per annum. When no more sulphur is released from the matte in the furnaces, it is once more roasted in open heaps and then added in the lead-ore smelting, where it is a welcome flux, replacing part of the copper-slag from Oker. This is repeated several times, until the matte contains 12 per cent. of copper, when it is transferred to that part of the copper-smelting (*Krätzkupferarbeit*) treating argentiferous copper-products from previous processes.

Copper-matte smelting.—The copper-matte is roasted from four to six times in open heaps and then concentrated by smelting it with siliceous fluxes (principally copper slag) in low shaft-furnaces with one tuyere, and closed front, (*Brillenöfen.*) This alternating roasting and concentration by smelting is repeated three to five times, when all the copper is converted into the form of black copper, that from the earlier smeltings containing a much higher percentage of silver and gold than the result of the last smeltings. The black copper is all partially refined and granulated, and then given over to the copper-vitriol works, which separate the silver and gold from it and convert the copper into a very pure sulphate, which is sold.

The processes employed for the beneficiation of the lead and copper mattes are very similar to those already mentioned in connection with the Clausthal Works, and are therefore not described here. Those who wish to get specific information on the subject are referred to the able article of C. Kuhlemann in Preussische Zeitschrift, &c., vol. xix, p. 197 *et seq.*, which treats these processes exhaustively.

The desilverization of the granulated copper and conversion of the copper into sulphate is based upon the circumstance that metallic copper is soluble in hot diluted sulphuric acid under access of air, while silver is not attacked. The latter runs off with the dissolved copper-vitriol in the form of a fine slime, and is deposited in the bottom of the extensive flumes and vats used in the process. The lead remains as sulphate with the silver; the antimony also remains as basic sulphate of antimony; most of the arsenic remains with the silver in the metallic state.

The silver-slime, together with the lead and impurities mentioned, is mixed with litharge and reduced, the main result being a very rich lead, which is cupelled. The resulting silver is sent to Lautenthal for refining.

This method of extracting the precious metals from copper-ores owes its existence to the necessities of the smelting-works of the Lower Harz, and to this date it has not been possible to replace it with a better one, though there are undoubtedly grave disadvantages connected with it. The process is now well known among metallurgists, and I will therefore not describe it in its details in this paper, especially as I intend to treat in my next report the same process (with only such slight modifications as the circumstances surrounding the works require) as practiced since October, 1873, in our own country.

In this connection late analyses of the copper-vitriol manufactured at Altenau, and of the silver-slimes collected, will be interesting. They will help to show, together with the analyses of the same products from the American works referred to, which I hope to give hereafter, how much more difficult is the treatment of the American mattes and black-copper than that of the same smelting products at the Harz.

Analysis of copper-vitriol from Altenau Works, by Professor Hampe, January 4, 1872.

Sb	0.0584	Fe	00171
As	0.0017	Zn	00035
Ni	0.0204	Pb	
Co			

Analysis of silver-slime from the copper-vitriol works at Altenau by Professor Hampe, February 26, 1872.

PbO, SO_3	54.61	37.32	Pb.
		2.87	O.
		14.42	SO_3.
CuO,SO_3+5HO	10.50	2.67	Cu.
		0.67	O.
		3.37	SO_3.
		3.79	HO.
FeO,SO_3+7Ho	0.50	0.10	Fe.
		0.02	O.
		0.16	SO_3.
		0.22	HO.
ZnO,SO_3+7HO	0.72	0.16	Zn.
		0.04	O.
		0.20	SO_3.
		0.32	HO.
NiO,SO_3+7HO	0.52	0.105	Ni.
		0.035	O.
		0.15	SO_3.
		0.23	HO.
CoO,SO_3+7HO	0.17	0.04	Co.
		0.01	O.
		0.05	SO_3.
		0.07	HO.
SbO_3	11.94	10.08	Sb.
		1.86	O.
AsO_3	1.33	1.03	As.
		0.30	O.
As	1.13		
Cu	0.19		
Ag	1.72		
AgCl*	2.09	1.54	Ag.
		0.55	Cl.

SiO_3, (soluble)	2
Wood and other admixtures	2.54
Sand	1.12
$SO_3,3HO$	2.22
CaO	0.20
Hygroscopic water	5.20
	98.56

NOTE.—By boiling seven times with concentrated sulphuric acid and evaporating to dryness each time, the silver could be completely extracted.

The following exhibit shows the quantities of raw material treated and of the final products obtained at the Altenan Works in 1872:

1. Lead and silver works:

Treated:		
Lead-ores	34,854	centner.
Foreign gold and silver ores	10,960	"
Total	45,814	
Produced:		
Refined pig-lead	20,329	centner.
Silver	9,823	pounds.
Gold	96	"
Sulphuric acid, (50°)	6,284	centner.
Argentiferous black copper	1,290	"

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* Originating from the additions to the copper-sulphate solution of NaCl, which was practiced at the time for the purpose of precipitating the silver which might be in solution. Now, this silver is precipitated by filtering the solution through granulated lead and copper.

2. Copper-works, (treating ores free from silver:)		
Treated:		
Copper-ores	8,759	centner.
Produced:		
Rosette-copper	1,374	"
3. Copper-vitriol works:		
Treated:		
Argentiferous black copper	4,093	"
Produced:		
Copper-vitriol	10,296	"
(From this copper were extracted 840 pounds of auriferous silver, which is, however, included above.)		

During this year an average of 197 workmen were employed at the works, at average wages of $\frac{2}{3}$ thaler = 48 cents per day. Coke cost 27 groschen = 64.8 cents per centner.

CHAPTER XVII.

THE DESILVERIZATION OF LEAD BY ZINC.

This chapter contains a description of the recent developments in Europe of the process originally introduced by Parkes, and known by his name, for the desilverization of argentiferous ores by means of zinc. It has been prepared at my request by Mr. Augustus R. Meyer, of Saint Louis, an educated metallurgist, and will be found to contain material additional to that presented in relation to this subject, in my report for the year 1870, by Prof. F. Prime, jr., of Lafayette College. The desilverization of lead-bullion is already practiced at many establishments in this country; and these records of foreign practice will be found convenient and instructive by American metallurgists.

INTRODUCTION.

The history of practical metallurgy in Europe, where operations sanctioned by time are very often obstinately retained, has very few examples to show of so rapid and universal an adoption of a new process as has attended that of Parkes. The Pattinson process, which permits the extraction of silver from lead containing only 2.625 ounces (0.009 per cent.) of silver per ton, with profit, had been introduced into practical metallurgy not long before the invention of Parkes's process. This circumstance, and the fact that the new process gave rise to a great many intermediate products, difficult to handle by existing methods, were naturally unfavorable to the spreading of Parkes's process. The difficulties in treating the intermediate products even led, at some places, to the rejection of the method, after it had already been practiced for some time. Improvements, however, which followed each other rapidly, soon established the new process as the most precise and cheapest; and it is now carried on at almost all European works of consequence.

Pattinson's process effects a concentration of silver in lead. Theoretically, the desilverization of lead by zinc is a separation of silver from lead. In practice, however, this is not the case. The argentiferous zinc cannot be obtained free from lead, and in consequence only a concentration of silver in lead is effected.

The desilverization of lead by zinc has the following advantage over Pattinson's process: The working costs are less; the process is carried out more easily, and in a shorter time; it is independent of the laborer's skill; the losses of lead and silver and the consumption of fuel are less. The following table shows the advantages obtained at Havre, by the substitution of Parkes's process (Corduriè's modification) for that of Pattinson's:

	Pattinson.	Parkes.
Tons of lead treated in twenty-four hours	10	20
Number of men employed	50-53	23
Consumption of coal in per cent. of the weight of lead	45-50	10
Loss of pure lead, per cent	4	1

The possibility of extracting silver from lead by zinc was discovered by Karsten in 1842. Karsten found that lead with from 16.9166 to 19.25 ounces (0.058 to 0.066 per cent.) of silver per ton is almost completely desilverized by fusion with zinc, the molten and well-mixed metals, if allowed to cool slowly, separating into two alloys. The upper of these alloys consists mainly of zinc and lead; and in it the greater part of the silver previously contained in the lead is concentrated; the other alloy is impure, zinciferous lead.

Parkes, who had no information of Karsten's experiments, obtained three patents on the desilverization of lead by zinc, in 1850, 1851, and 1852.

His process was first carried out at the Llanelly Lead-Works in 1851, and induced Karsten to again take up his experiments on a larger scale, at the Friedrichshütte near Tarnowitz, in Silesia. The experiments were made by Lange, under Karsten's direction; they did not lead to the application of the new method to practical metallurgy, on account of "the difficulty of freeing the lead treated from zinc," and of extracting the silver from the argentiferous zinc-alloy without loss.

The process was again taken up in Germany, with more favorable results, at the works of Pirath & Jung, at Commern, and at those of Herbert & Co., in the Eifel, in 1866.

Roswag, a Frenchman, experimented on Parkes's process in Spain, in 1859, and several patents were granted to him, one in 1859, (Spain,) a second in 1861, (France, England, and Belgium,) and a third in 1862, (Italy.) In 1863 comparative experiments were made by Mr. Roswag at the Tyne Lead-Works, near Newcastle, which led to a combination of the processes of Pattinson and Parkes.

Nature of Parkes's process.—Argentiferous lead is melted together with zinc in sufficient quantity, and at a proper temperature; the silver is thereby extracted from the lead, and conveyed into an alloy, argentiferous zinc, which, on account of its higher melting-point and lower specific gravity, solidifies first, and separates on the surface of the metal-mixture, if this be allowed to cool slowly. The two products obtained are:

1. Argentiferous zinc.
2. Desilverized, zinciferous lead.

These two products are subjected to different treatment, the first finally yielding silver, and the other, refined, marketable lead.

Parkes's process consists, therefore, of the following operations: I. Zincification; II. Refining of the desilverized lead; III. Treatment of the argentiferous zinc.

I.—ZINCIFICATION.

The zincification comprises the formation and the separation of the alloys.

The formation of the argentiferous zinc requires a certain temperature and duration and an intimate mixture of the lead and zinc. A complete separation of the alloys is only obtained by a slow cooling, during a long period of quiescence of the metal-mixture.

The extraction of silver from lead, that is, the formation of argentiferous zinc, is not limited; whereas the complete separation of the alloys is influenced by practical difficulties, so that the desilverized lead always retains a small quantity of argentiferous zinc, and consequently of silver. The limit of desilverization is at 0.0583 ounce (0.0002 per cent.) of silver.

The process of zincification is carried out as follows:

The argentiferous lead is melted in a kettle, and the dross is removed. The temperature of the lead is then raised to the melting-point of zinc, whereupon zinc is added, and both metals are mixed intimately by stirring, care being taken to keep up the temperature during this period. After the mixture is completed, the fire is damped with wet fuel, so that the metal-mixture may cool slowly, and the cooling may take place mainly from the surface. As soon as the formation of a ring of zinc round the pot has taken place (about 1 inch in thickness) the skimming is commenced. The ring of zinc is first removed, one laborer loosening it, and the other catching the loosened pieces in a perforated ladle, so as to prevent anything from falling back into and enriching the subjacent lead. This completed, the solidified zinc-crust is taken off with perforated ladles. As the metal-mixture cools more and more, new portions of argentiferous zinc solidify on the surface, and are also taken off. The surface of the skimmed lead has an indigo-blue color. The skimming of the lead is stopped as soon as an assay of the lead shows sufficient desilverization, and the desilverized lead is then given over to the refining process. During skimming care must be taken to prevent the formation of too thick a ring of zinc. At Lautenthal, the operations differ somewhat from those described. After the ring of zinc is removed, and the solidified crust of zinc taken off, the argentiferous zinc deposited on the sides of the kettle, under the surface of the metal-bath, is scraped off. The mass hereby rising to the surface has a mushy appearance, similar to the lead-crystals of the Pattinson process.*

The desilverizing zinc may be added in the molten state or in pieces. No benefit is derived by previous melting of the zinc, but only an addition of apparatus necessitated, and the latter method is therefore the one most practiced.

The zinc may be added, moreover, in one portion or in several successive portions. Generally the zincification is carried out with successive additions of zinc, which is of no direct influence, but indirectly important, since the complete desilverization is largely dependent on the length of the period of repose. It is, therefore, possible to obtain the same results with a single addition of zinc, if the process of firing and cooling be repeated several times.

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* Mr. Koch, chemist of the works at Lautenthal, informed me during my presence there, that, according to his experience, this mass, which he believed to be an accumulation of crystals of argentiferous zinc, was richer in silver than the argentiferous zinc, which solidifies on the surface of the metal-bath. It was Mr. Koch's intention to construct an apparatus which, cooled by a current of water, should effect an accumulation of the argentiferous zinc on its surface, when lowered into the metal-mixture. Mr. Koch has published his ideas lately, in the Berg-und-Hutten-männische Zeitung, 1873, page 261.

The modes of operation of these two methods differ somewhat. The zincification with a single addition of zinc completes each operation without interruption, whereas the zincification with successive additions of zinc carries out the operations repeatedly and alternately. In the former method, the skimming of the metal-surface is continued until perfect desilverization. If the metal has cooled off so far—before sufficient desilverization—as to allow skimming no longer, it is reheated; and thereupon the process of cooling and skimming is repeated. In the latter method, the skimming of the metal surface, after the addition of the first zinc-portion, is carried on until the lead begins to crystallize, whereupon the temperature is again raised to the melting-point of zinc, the second portion of zinc added, and the process of zincification repeated, &c., until perfect desilverization.

The intimate mixture of lead and zinc is effected either by hand (with perforated ladles) or by machinery. Mixing by hand is more thorough than by machinery, and therefore preferable. Figure 1 shows the apparatus of Mr. Cordurié, as used at the works of Mr. Rothschild, at Havre. The charge of zinc is put in the perforated box *a;* the apparatus is then lowered into the molten lead (the temperature of which has been raised to the melting-point of zinc) and put in rotation. The zinc melts, passes through the perforations of the box, ascends in the lead, and is then mixed with this by the agitator *b.* After complete fusion of the metal the apparatus is removed, and the mixture of lead and zinc completed by stirring with ladles during a few minutes. An apparatus similar to this one has already been used by Mr. Roswag.

At the time Karsten experimented at Tarnowitz, Lange carried out the zincification as follows: each metal was melted in a separate vessel, and when both metals were skimmed, the lead was poured into the zinc through a perforated iron plate, so that it descended through the zinc in drops.

Consumption of zinc.—The amount of zinc absorbed by the process, though chiefly dependent on the contents of silver in the lead, cannot be precisely determined, because it maintains no fixed proportion to the contents of silver, and moreover a number of accessory circumstances, such as impurities in the lead, manipulation, &c., are of influence. Roswag, the metallurgist already mentioned, determined the amount of zinc necessary for complete desilverization by the following formula: $Z = 10 + 0.019\,t$, in which t stands for the grammes of silver in the ton, (1,000 kilograms,) and Z signifies the amount of zinc necessary, in kilograms. According to Gruner, this formula always gives the amount of zinc too high for rich lead.

Karsten applied 1.5 per cent. of zinc for the desilverization of lead with from 16.9166 to 41.2707 ounces. (0.058 to 0.1415 per cent.) of silver; (this corresponds to 20 and 10.6 parts Zn to 1 Ag.) Flach and Illing give the following proportions for complete desilverization.

Illing.			Flach.		
Ounces of silver to the ton of lead.	Addition of zinc, per cent.	Proportion of zinc to silver.	Ounces of silver to the ton of lead.	Addition of zinc per cent.	Proportion of zinc to silver.
7.2917	1.25	50 : 1	29.1666	1.0833	10.833 : 1
14.5833	1.33	26.6 : 1	43.7500	1.2500	8.333 : 1
29.1666	1.50	15 : 1	87.5000	1.5000	5.000 : 1
43.7500	1.66	11.1 : 1	145.8330	1.8750	3.750 : 1
87.5000	2.00	6.6 : 1	262.4990	2.0000	2.222 : 1
116.6660	2.00	5 : 1	....	....	....

At the furnaces near Clausthal, Harz, experiments established that lead of the Upper Harz with 36.4583 ounces (0.124 per cent.) of silver was sufficiently desilverized by 1.66 per cent. of zinc (13.3 Zn : 1 Ag.) but not by 1.5 per cent., (12 Zn : 1 Ag.)

At the Friedrichshütte, near Tarnowitz, the consumption of zinc, in treating lead with 29.1666 ounces (0.1 per cent.) of silver was formerly 1.42 to 1.44 per cent., (from 14.2—14.4 Zn : 1 Ag.) Treating lead with higher contents of silver, it was found that this consumed comparatively less zinc, and consequently it was supposed that the zinc in the skimmings resulting from poor lead was not entirely saturated. This supposition led to experiments tending to make use of the second and third zinc-skimmings of a previous charge, by giving them to a subsequent charge as first addition of zinc. The results hereby obtained are given in the following table:

No.	Weight of lead.		Ounces of silver to the ton.	Weight of zinc-skimmings.		Addition of zinc.		Ounces of silver in lead after addition of zinc.		
						I.	II.	Zinc-skimming.	I portion.	II portion.
	*Ctrs.	Lbs.		Ctrs.	Lbs.	Lbs.	Lbs.			
I.	219	60	27.9708	57	73	100	50	11.0250	2.8583	0.1750
II.	235		26.9791	79	30	100	50	4.2292	0.7000	0.0583
III	210		25.9583	46	35	100	50	14.2916	1.0500	0.1750
IV	220		18.9583	54	60	100	50	9.3333	0.8167	0.1458

* One German centner = 100 pounds = 50 kilograms = 110 pounds English.

It appears from this table that, using second and third zinc-skimmings as first addition of zinc, 150 pounds of zinc sufficed to desilverize about 220 centners of base bullion, whereas from 310 to 325 pounds were used formerly. This corresponds to a decrease in the consumption of zinc of from 1.42–1.46 to 0.68 per cent. Since the whole quantity of zinc-skimmings cannot be utilized as here described, the consumption of zinc amounts to about 1 per cent. In the Upper Harz the same experiments have been made, but they were not successful, as the zinc-skimmings were too rich in copper, and the lead fused therewith was enriched in copper.

Influence of manipulation.—We have seen that the following conditions are required for a complete desilverization: a certain temperature and duration of the same; an intimate mixture of zinc and lead; slow cooling of the metal mixture, and careful skimming of the metal surface. Gurlt, who describes Parkes's process as in operation at the Llanelly Lead-Works, says that the temperature would not exceed 400° C., as the desilverized lead would otherwise retain too much zinc. The experiments made at Tarnowitz, under Karsten's direction, tended to determine the minima of time and amount of zinc necessary for complete desilverization. The following table gives the results obtained:

No. of experiment.	Quantity of lead operated on.	Contents of silver in lead.	Addition of zinc.	Length of stirring-period.	Length of resting-period.	Contents of silver in desilverized lead.	Remarks.
	Ctrs.	*Oz.*	*Per ct.*	*Hours.*	*Hours.*	*Oz.*	
I..........	20	38.735	5	2	6	0.1424	Metal-bath was covered with charcoal; after stirring, the temperature remained the same; only near the end of six hours the temperature was lowered, and water was sprinkled on the surface in order to solidify the upper layer of metal.
II..........	20	27.342	5	1	4	....	Desilverized lead was free from silver.
III..........	20	27.342	2.50	1	4	....	Desilverization was complete.
IV..........	20	22.785	.75	1	4	4.577	

* One old centner = 103.11 pounds English.

The results of the foregoing and a series of similar experiments showed that, proceeding in the manner described in the table, the addition of 1½ per cent. of zinc, and stirring during an hour, must be considered as the minima. The desilverization of 25 centner of argentiferous lead was completed in four hours.

Karston next proposed to allow the metal mixture to solidify in the kettle, and then to separate the lead by liquation. The experiments in this line were not successful, as it was impossible to restrict the fusion wholly to the desilverized lead.

In the last series of experiments made at Tarnowitz the idea was to use a certain portion of zinc repeatedly for desilverization. The process was conducted as follows: Lead and zinc were melted together, and mixed intimately. After the metal mixture had been kept at a red heat during four hours, the lead was cautiously tapped off through a cast-iron pipe ½ inch in diameter, inserted on a level with the bottom of the kettle. In the kettle remained about 6 centner of argentiferous alloy, which was again used for desilverization. The charge consisted of 25 centner lead, with 15.95 ounces silver, and 4 centner zinc. The process was repeated seven times without addition of fresh zinc excepting the third and fourth charges, each of which received 2 centner of extra zinc. The lead obtained from the first six charges was completely desilverized, whereas the lead from the seventh charge retained 6.834 ounces of silver.

It appears from the first six trials that 5½ per cent. of zinc was required for the desilverization of lead with 15.95 ounces of silver, whereas, in the preceding experiments with a single fusion, only 1½ per cent. of zinc was needed. Another inconvenience of this mode of conducting desilverization was the formation of large quantities of dross. Karsten ascribed the unfavorable results of the last experiments partly to the formation of this dross, but experiments in the laboratory did not prove this to be the case. It was the incomplete separation of zinc from lead on which the process was wrecked.

The following examples show still more plainly the influence of manipulation on complete desilverization:

At Clausthal base bullion with from 37.9166 to 40.833 ounces (0.13 to 0.14 per cent.) of silver, 0.285 per cent. Cu, 0.003 Fe, and 0.442 Sb, is sufficiently desilverized by 1.4 per cent. of zinc, (10.8 to 10 parts Zn : 1 part Ag,) which is added in three portions. The desilverized lead only retains from 0.1160 to 0.1458 ounces (0.0004 to 0.0005 per cent.) of silver.

At Call, in the Eifel, the base bullion contains 14.5833 ounces (0.05 per cent.) of silver, 0.5 per cent. Sb, and 0.01 per cent. Cu. The consumption of zinc amounts to 1.4 per cent., and the desilverized lead retains only 0.0583 ounces (0.0002 per cent.) of silver.

At both places the metals are mixed by stirring with perforated ladles during 20 or 30 minutes, whereupon the metal mixture is allowed to cool slowly. The process is carried out with successive zinc additions at intervals of two hours.

At Pise, in France, 2 per cent. of zinc are consumed for the desilverization of lead with 29.166 ounces (0.1 per cent.) of silver, (20 Zn : 1 Ag.) The desilverized lead contains from 0.29166 to 0.4375 ounces (0.001 to 0.0015 per cent.) of silver. Cordurié's apparatus is here used for zincification. The time between two additions of zinc does not much exceed an hour. The time left to the metal mixture for cooling is doubtless too little, and this is the cause of the high contents of silver in the desilverized lead.

Influence of the contents of silver.—It is a well-established fact that lead richer in silver is more rapidly desilverized than is the case with poor lead. Illing gives the following illustrations. The columns under I give the results at Call, under II the results at the Clausthaler Hütte:

	Ounces of silver.		Quantity of silver abstracted after zinc addition.			
	I.	II.	I.		II.	
Original lead	8.2541	36.4583	100		100	
				3·4		1·5
Lead after first addition of zinc	6.1250	7.2917	74		20	
				2·9		1·6
Lead after second addition of zinc	1.4583	1.2250	17		3.36	
				1·8		1·8
Desilverized lead	0.1750	0.1458	2.2		0.4	

Behavior of zinciferous lead.—In 1868 base bullion of the Lower Harz was sent to Lautenthal in order to ascertain whether Parkes's process was practicable for this impure lead. The results, as far as the extraction of silver is concerned, were striking. While the contents of the silver in the purer lead (*Schliechblei*) of the Upper Harz were reduced from 37.9166 — 43.75 ounces (0.13 — 0.15 per cent.) to 4.375 — 8.75 ounces (0.015–0.03 per cent.) by the second addition of zinc, the impure lead of the Lower Harz only retained 2.9166 ounces (0.01 per cent.) of silver after the application of the second zinc portion. This favorable behavior was found to be due to the zinc already contained in the base bullion.

Cordurié also found that a given amount of zinc added to zinciferous lead, will extract the silver more rapidly than if the lead be pure.

This phenomenon may be explained by supposing that the formation of argentiferous zinc had already taken place in the zinciferous lead, to a certain extent. This explanation is supported by the fact that a subsequent addition of zinc always desilverizes with comparatively greater rapidity than did the preceding.

Contents of zinc in the desilverized lead.—Karsten, examining the influence of foreign metals on zinc, found that zinc and lead when melted together always separate into two alloys, plumbiferous zinc and zinciferous lead. The maxima of metals taken up have been determined as follows:

Analyst.	Lead in zinc.	Analyst.	Zinc in lead.
	Per ct.		*Per ct.*
Karsten	2.50	Richter	1.50
Lange	2.00	Lange	1.60
Richter	1.22	Mathiessen	1.62

Generally desilverized lead does not retain more than 0.75 per cent. of zinc.

Influence of foreign metals.—Impurities in the lead to be desilverized cause the formation of dross on the metal-surface. The dross must be removed before adding zinc.

Antimony hinders a complete desilverization; and lead containing a large quantity must be refined before zincification. Zinc does not extract the antimony from lead; antimony is only removed by subsequent refining.

Copper has a greater affinity for zinc than silver, and can therefore be extracted from lead, without taking much silver into the alloy, if zinc is added in such quantity as to saturate only the copper. This is another merit of Parkes's process, as it effects the production of lead free, or nearly free, from copper.

The extraction of copper from lead by zinc is so complete that Mr. Baker has based a method of decopperizing lead upon it. It is evident that copper in the argentiferous lead increases the consumption of zinc.

Gold also has a greater affinity for zinc than silver, and the latter is only extracted after gold and copper are removed. This is made use of, and the process is so regulated that the first zinc-skimmings contain all the gold and copper.

At Lautenthal 49.5 pounds of zinc are added to 27,500 pounds of lead (1 pound = 1.10 pounds English) for the extraction of copper and gold. The skimmings contain all the gold and copper, and are not much richer in silver than the original lead. The silver made from these skimmings contains from 34.9999 to 58.333 ounces (0.12 to 0.2 per cent.) of gold.

At Call, 180 pounds of zinc are added to 300 centner (at 110 pounds English) of base bullion. About 10 centner of zinc-skimmings are obtained, which contain the gold and copper. This gold-copper scum is treated with the residues of the treatment of the argentiferous zinc, and the silver finally obtained contains 29.1666 ounces (0.1 per cent.) of gold.

Bismuth is not extracted by zinc.

Illing gives the following results of the elimination of other metals along with silver obtained at German works:

Metals.	In the original lead.	In the lead after removal of zinc-skimmings.		
		After first portion of zinc.	After second portion of zinc.	After third portion of zinc.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*
Antimony	0.035	0.034	0.048	0.046
Copper	0.161	0.003	0.007	0.006
Iron	0.005	0.006	0.003	0.004
Zinc	0.006	0.227	0.541	0.777
Silver	0.0283	0.021	0.005	0.0062

II.—REFINING OF THE DESILVERIZED LEAD.

Refining has in view the separation of foreign metals from the lead, so as to make it suitable for purposes of manufacture. As different metals influence different qualities of the lead it will depend upon the use to be afterward made of the refined lead whether the separation of a certain metal must be more or less complete; and the process of refining is conducted accordingly. Corroding-lead, for instance, must contain very little copper, (not more than 0.0014 per cent., according to Hampe,) whereas the influence of copper upon the malleability is not so delicate.

As already remarked, desilverized lead retains zinc. According to Lange the maximum of zinc retained is 1 per cent., but generally the amount does not exceed 0.75 per cent. This proportion of zinc makes lead brittle and unsuitable for various purposes of manufacture. But zinc is not the only impurity in desilverized lead. The lead which is subjected to desilverization generally being impure, this is also very often the case with the desilverized lead, as this contains all impurities which are not extracted by zinc. Hence, antimony, arsenic, and bismuth may be contained in desilverized lead; of these antimony is the most frequent. All these metals, bismuth excepted, have a strong affinity for oxygen, and can, therefore, be separated by oxidation. In a series of methods chlorine is used for refining desilverized lead; but this only effects the removal of zinc, and the lead, if dezincified by this process, must, therefore, be subjected to further refining in case other impurities are contained in it. Bismuth cannot be separated from lead by oxidation, as the latter has a stronger affinity for oxygen. As bismuth, moreover, cannot be removed by chlorine, it appears that lead with a large proportion of bismuth cannot be advantageously subjected to desilverization by zinc, as the lead produced could not be freed from bismuth, and would, therefore, not be marketable. Base bullion containing considerable quantities of bismuth is, therefore, treated by the Pattinson process, and then cupelled. Smelting the first portions of litharge formed in the cupellation produces a pure lead.

It has for a long time been the endeavor of practical metallurgists to find a good method for refining desilverized lead. The large amount of zinc contained in this lead necessarily calls special attention to the removal of that metal, particularly as in some cases it is the only impurity. Antimony, the only impurity of desilverized lead, besides zinc, which need be here considered, can be completely removed by the softening process. It is, therefore, only necessary to have a good method for the removal of zinc. As zinc renders smelting in the blast-furnace difficult, a perfect method must effect the concentration of zinc and antimony in separate products, and must convey the zinc into a product which requires no further treatment, or, at least, no treatment in the blast-furnace. In most recent trials the removal of zinc and that of antimony is, therefore, effected by different agents, and both are concentrated in separate products. All methods which have been employed for refining desilverized lead may be classed as follows: 1. Methods which effect the simultaneous removal of all impurities; 2. Methods which effect the removal of zinc and antimony separately.

In the former class we have, first, the softening process; and, secondly, methods of refining by special agents of oxidation, under which may be distinguished a current of hot air, nitrate of soda, and litharge. Of all these methods only the softening process has been introduced into practical metallurgy. The others are open to the common objection, that they collect the zinc in skimmings which must be returned to the blast-furnace for further treatment, where the proportion of zinc contained is a hinderance to the lead-smelting, and is itself lost.

The softening process.—This process, which is the oldest in use for refining desilverized lead, has been abandoned at most European works, and replaced by better methods. As will be seen below, it is the best method for the removal of large quantities of antimony, and in the treatment of lead with large contents of antimony softening is, therefore, still employed; but in such cases it is performed either before desilverization, or after the removal of zinc by some other method. The process is characterized by the slowness of the reaction, and, as the temperature required is relatively high, involves large losses of metal. Large quantities of lead are oxidized together with the impurities, and the percentage of oxides formed is very large. The long duration and high temperature of the process cause, moreover, a large consumption of fuel and labor.

At the Llanelly Lead-Works in Wales, where the process was first used for refining desilverized lead, it was carried out as follows: The charge was 10 tons of desilverized lead; the temperature used was a good red heat, and the average time needed for completion of the process was nine hours. The lead was skimmed three hours after charging, and about half an hour before tapping. After the completion of softening, the lead was tapped into a cast-iron kettle and here poled. No zinc could be detected in the refined lead.

At Lautenthal refining desilverized lead by the softening process has been tried, but was soon abandoned, as it caused large losses of metal, and was connected with a large consumption of fuel and labor.

Refining by special agents of oxidation.—At Lautenthal a trial was made to effect the refining of desilverized lead by a current of hot air; but the results were unsatisfactory. Large quantities of lead were oxidized with the impurities. A perfect removal of antimony was only effected after the zinc had been removed by chlorination.

In a second series of experiments, nitrate of soda was the agent used for oxidation. The salt was put into a perforated box and this lowered into the molten metal. Complete refining was effected, but the quantity of lead oxidized with the impurities was so large as to make the process impracticable. A last trial, made at Lautenthal with litharge, was conducted as follows: Litharge was thrown on the surface of the molten lead, and intimately mixed with the metal by poling. The lead was thereby completely refined, but the favorable result was found to be due to poling, as the temperature was not high enough to melt litharge, so that this did not enter into reaction. At Braubach, however, this process was successfully carried out in a reverberatory furnace, in which a sufficient temperature was easily attained.

We now come to the methods which effect the removal of zinc and antimony separately. Under this head two processes are to be distinguished: first, the dezincification by chlorination, and removal of the remaining impurities by some other agent; and secondly, the dezincification by the decomposition of steam, and the oxidation of antimony by the oxygen of the atmosphere.

Dezincification by chlorination, and removal of the remaining impurities by some other agent.—Slow reactions and low temperature are the characteristics of this process, at least in the first operation. It may be carried out in a kettle or in a reverberatory furnace, and at some places the two operations of the process have even been performed in different apparatus.

The process, which is a German invention, has been extensively experimented upon, and various modifications were once in operation in Germany, but Cordurié's process has replaced them almost everywhere. At Call, in the Eifel, a modification of this process is still in operation, and gives, it is said, satisfactory results. At Lautenthal and Tarnowitz the process was connected with large losses of metal, and a large consumption of fuel and labor; it has, consequently, been replaced by Cordurié's process.

By the chlorination process, the zinc contained in the desilverized lead is conveyed into a slag, which consists of the chlorides and oxides of zinc and lead. As this product contains lead, it is returned to the blast-furnace, where it renders smelting difficult. The zinc previously contained in the desilverized lead is entirely lost.

The chlorination of the zinc is effected by a chloride, or by a mixture of a chloride and a sulphate; the operations are the same in both cases. The process is carried out as follows:

After the molten lead has been brought to a dull red-heat, the chloride or the salt mixture is added, and intimately disseminated by frequent stirring. Two products are obtained, the chloride-slag and the dezincified lead. The chloride-slag is added to smelting in the blast-furnace; the dezincified lead, if it contains antimony, is subjected to further treatment.

The substances used for dezincification are chloride of lead, chloride of sodium, a mixture of chloride of sodium and sulphate of lead, a mixture of sulphate of lead with Stassfurth salts, (chlorides of sodium, potassium, and magnesium,) Stassfurth salts alone. The results of experiment with each of these will be given in the order named.

At Call, chlorination of zinc was formerly effected by impure chloride of lead, (containing 62 per cent. of lead,) according to the following reaction:

$$\mathrm{Pb\,Cl + Zn = Zn\,Cl + Pb.}$$

4.7 per cent. of the impure chloride of lead, which was prepared by treating lead-fumes with hydrochloric acid, was consumed. Dezincification was carried out in a Pattinson kettle, and completed in twenty-four hours. The following results were obtained:

	Percentage of foreign metals.	
	Before Chlorination.	After Chlorination.
Zinc	0.777	0.005
Copper	0.008	0.011
Iron	0.004	0.005
Antimony	0.046	0.010

Illing ascribes the decrease of the contents of antimony partly to oxidation of this metal by the oxide of lead existing in the impure chloride of lead, and partly to the formation and volatilization of chloride of antimony.

The dezincified lead was freed from antimony by oxidation in the softening-furnace during twenty-four hours. The resulting lead contained the following impurities:

Zinc	0.003
Copper	0.007
Iron	0.005
Antimony	0.003

At Commern dezincification is carried out in a reverberatory furnace, in which the lead is kept melted, under a layer of 1 per cent. of common salt, for eight to ten hours. Intimate mixture is effected by poling. According to Illing, oxide of lead is formed, which, entering into a compound with oxide of sodium, causes the evolution of chlorine, which combines with zinc. The lead of Commern does not contain antimony, and the dezincified lead is therefore marketable. According to Percy, experiments in England have shown that, without adding salt, the lead would have been ready for tapping after four or five hours. Illing gives the following composition of the dezincified lead:

Zinc	traces.
Copper	0.0021
Iron	0.0180
Antimony	0.0028

Chlorination by a mixture of salt and sulphate of lead has been substituted at Call for dezincification by chloride of lead. The reactions of this process are:

$$PbO,SO_3+NaCl+Zn=ZnCl+NaO,SO_3+Pb$$

The conduct of this process has been somewhat changed. At present it is as follows: From 1.15 to 1.2 per cent. of sulphate of lead, and 0.38 to 0.4 per cent. of common salt (referred to the weight of desilverized lead) are added to the desilverized lead, and this is kept at a dull red-heat during twenty-four hours. The lead and salt mixture are well mixed by stirring. As the reactions take place mainly on the surface of the lead, the operation is carried out in a shallow kettle, a little over 8 feet in diameter, and about 3 feet in depth. The complete removal of zinc is indicated by small spots, or a line, of a peculiar white color, appearing on the surface of a sample at the moment of solidification. This appearance is ascribed to the formation of an alloy, consisting of zinc and lead, which separates on the surface of the sample; it is a concentration of the zinc contained in the sample in a small area. This indication is said to be so delicate as to show traces of zinc, which cannot be detected by a humid test. The charge of desilverized lead for one operation is 12½ to 13 metric tons; the slag produced is 1.31 to 1.4 per cent. of this weight, and contains 25 per cent. of lead; twenty-four hours are required for complete dezincification.

The dezincified lead contains antimony, which was formerly removed by poling. At present the removal of antimony is effected as follows: About 0.3 per cent. of lime is mixed with the dezincified lead by stirring. The lime extracts the antimony, forming a black scum; after the operation has been carried on for twelve hours, the scum which has collected on the metal-surface is taken off, the lead once more stirred well for about fifteen minutes, and the scum rising on the surface also removed, and added to the first. The remaining lead, which is now completely refined, contains:

Metals.	Per cent.
Sb	0.0008 to 0.0016
Cu	0.0004 to 0.0005
Fe	0.0019 to 0.0023
Zn	traces.
Bi	0.0023 to 0.0024
Th	0.0003
Ag	0.0005

The method for the removal of antimony is only advantageous for small quantities of antimony. The scum resulting from dezincification and that from refining of antimonial lead are treated together; they are passed through the blast-furnace together with iron-slag. The zinc is conveyed into the slag, and lead with from 2 to 3 per cent. of antimony is produced. This lead is treated with lime in a manner similar to that described above. The greater part of the antimony is extracted by the lime, and lead is produced which can be rolled and is therefore marketable. The skimmings taken from this lead are again passed through the blast-furnace, and yield lead with from 10 to 14 per cent. of antimony. This lead is melted in a kettle, refined by adding 0.5 per cent. of nitrate of soda, and then sold for type metal.

The refining method used at Call is said to give very good results, and to cause only small losses of lead, as the temperature is very low. Passing through the establishment where this process is carried out, no metal-fumes can be perceived arising from the refining-kettles.

Formerly the slag obtained from dezincification of desilverized lead was treated with water acidulated by hydrochloric acid. The residue consisted of sulphate of lead, whereas copper and silver were dissolved as chlorides (the latter on account of the presence of other soluble chlorides.) The silver was first precipitated by copper, then the copper by iron, and then the iron by lime. Zinc is lastly precipitated, also by lime, but out of a boiling solution.

Chlorination by Stassfurth salts, or by a mixture of these salts with sulphate of lead, was successfully tried at the Royal Silver-Works of Clausthal. The mixture of these salts and sulphate of lead was found more advantageous than the salts alone. The lead was kept melted with frequent poling under a layer of 2 per cent. of the salt-mixture for twenty-four hours. The dezincified lead was yet brittle, (from antimony,) and was therefore subjected to softening in the cupellation-furnace.

The changes in composition, which the desilverized lead underwent during refining, are shown in the following table:

Metals.	Original lead.	After heating 12 hours in the kettle.	After heating 24 hours in the kettle.	Lead softened in the cupellation-furnace.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Copper	0.1070	0.0054	0.0064	0.00062
Antimony	0.6208	0.0096	0.0080	0.0058
Iron	0.0032	0.0034	0.0019	0.0018
Zinc	0.0013	0.0034	0.0024	0.0024
Silver	0.1200	0.00063	0.00063	0.0013

The impure litharge obtained by softening was reduced to hard lead. The scum resulting from dezincification of desilverized lead was passed through a low-blast furnace, in admixture with the scraps formed in ladling the refined lead from the kettles.

Dezincification by decomposition of steam, and oxidation of antimony by the oxygen of the atmosphere.—This method appears in two modifications: first, refining by poling; and secondly, refining by Cordurié's process. Both modifications are based upon the chemical behavior of the impurities of desilverized lead—zinc and antimony—toward steam, at a high temperature. Under this condition, steam is decomposed by zinc, which is thereby oxidized, whereas the antimony is not attacked by steam. Antimony, however, may be oxidized by the oxygen of the atmosphere. These two modes of oxidation are effected by the same agent, steam, in both modifications of the process; but while the oxidation of zinc is effected by the chemical action of steam, this agent has only a mechanical effect in the oxidation of antimony. The boiling caused by the steam effects a continual renewal of the metal surface, and therefore promotes the oxidation of antimony by the air.

As long as zinc is present, antimony is not oxidized; and it is therefore possible to collect antimony and zinc in separate products. Lead is oxidized along with both zinc and antimony, in varying quantities; but the oxidation is larger in the first part of the process, during the oxidation of zinc. After the zinc is removed, antimony is attacked, but only little lead is oxidized along with it. Violent oxidation of the lead takes place after the removal of antimony.

The success of the process largely depends upon the temperature employed, which ought to be cherry-red. At a high temperature a smaller quantity of oxides is formed, and the oxides produced are richer in zinc, a more complete refining is effected, and the process is completed in shorter time. On the other hand, a high temperature augments the corrosion of the kettles, and causes the formation of ferruginous lead. A low temperature increases the quantity of oxides, and may protract the process to such a degree as to render it unprofitable.

The advantages of this method over those described above are: First, greater rapidity and consequently large savings in the consumption of fuel and labor; second, smaller quantities of intermediate products; third, the accumulation of zinc and antimony in separate products.

In the poling process oxidation is effected by keeping green wood submerged in the molten lead. As the process is carried out in open kettles, the quantity of lead oxidized along with zinc is increased, so that a larger quantity of zinciferous oxides is produced than by Cordurié's process. Poling was already used by Roswag in 1863 for refining desilverized lead. The desilverized lead was poled in a reverberatory furnace, at a red heat.

A trial made in the Harz with this method gave highly advantageous results. The following table furnishes a comparative view of the old process (refining by chlorination and subsequent oxidation) and the poling process:

	Time for completion of the desincification.	Consumption of fuel.*	Costs for labor.
	Hours.	*Per ct.*	
Old process	24	14	6 gr. = 14 cents gold.
Poling	5-6	10	5 gr. = 12 cents gold.

* In per cent. of the weight of the desilverized lead treated.

The yield of refined lead was 74 to 76 per cent. in both cases.

The loss of lead in poling was 1 per cent. A disadvantage of the new process was the rapid corrosion of the kettles. At Lautenthal 180 centners of lead, (at 110 pounds English,) containing 0.7 per cent. of zinc and

1 per cent. of antimony, were so completely refined by poling during nine to ten hours that the impurities remaining in the lead only amounted to 0.0068 per cent. Of the ten hours six were used for dezincification.

By Cordurié's process a high degree of perfection has been attained in the refining of lead, and the old methods have been almost everywhere superseded. This process effects oxidation of the impurities by a jet of steam passed into the lead, and excludes the air during the oxidation of zinc, while in the second period (removal of antimony) the air has full access. This arrangement secures the oxidation of zinc by the oxygen of the steam exclusively, whereas in poling zinc is oxidized partly by decomposition of steam, partly by the air, which has free access throughout the process. Consequently, the Cordurié process is completed in less time; the zinciferous oxides are richer in zinc, and the quantity of oxides is less than is the case in poling. The losses of metal are, moreover, less, and the workmen do not suffer so much from the metallic fumes, owing to the hood which covers the refining kettle.

Cordurié's process is carried out as follows:

The refining kettle is covered with a hood of sheet-iron. In order to give the lead the cherry-red heat required for the process, the metal surface is covered with charcoal and the fire urged. The temperature attained, steam is now passed into the lead, but only after the conveying pipes have been freed from water, which, if blown into the lead, would cause serious explosions. During the oxidation of the zinc all the doors must be closed, in order to exclude the air. The zinc is oxidized by decomposition of the steam, and rises to the surface as oxide of zinc, where it melts with oxide of lead, formed on the metal surface. In the beginning of the process the oxide-mixture is semi-fluid. Steaming is continued until the mixture is perfectly dry, which is a sign of completed dezincification. Another test for zinc is to take a ladleful of lead, and pour this out in drops after it has cooled somewhat. If the lead is not completely dezincified, the zinc contained in the drops of lead will solidify and remain behind, forming *Zinklappen*, (zinc rags,) which hang down the ladle. The non-appearance of these *Zinklappen* is a sign of completed dezincification. A crystalline star on the surface of a solidified sample of the lead indicates the presence of antimony, in which case the lead is subjected to further steaming after the zinciferous oxides have been removed. The doors of the hood are open during this operation, in order to allow the air full access. In this period mainly antimony is oxidized, with little lead, the oxidation of which rapidly increases as soon as all antimony is removed. The sign for completed refining is the formation of "gold-litharge" on a skimmed sample. At Tarnowitz the completion of refining is determined by pouring a sample of the lead, after it has cooled somewhat, on a stone. In case of pure lead the plate of lead is plain, and shows large crystalline faces. If the lead is pure, the hood is removed, the antimonial oxides are taken off, and the lead, after it has cooled, is ladled into molds. The hood which covers the refining-kettle is connected with condensing chambers, where the powders, which have been carried away by the hydrogen and the excess of steam, are deposited.

At Havre the desilverized lead contains 0.75 per cent. of zinc and very little antimony. Dezincification is carried out in separate kettles, which hold only half the quantity of lead treated in the desilverization kettle.

The high temperature employed in Cordurié's process, and the antimony contained in desilverized lead, effect a rapid corrosion of the kettle during refining, and cause the formation of cavities in it. If refining and desilverization are carried out in the same kettle, argentiferous zinc may settle in the cavities during zincification, and can therefore not be removed by skimming. In refining the desilverized lead, the deposits are thrown out of the holes by the violent agitation in the metal-bath, and the lead is thereby enriched. For this reason refining in separate kettles, which is highly advantageous, has been introduced at Havre. In order to facilitate the process, two kettles are used for refining one charge of desilverized lead.

At Havre superheated steam of 60 to 70 pounds' pressure is pressed into the lead, and refining is completed in three hours. The lead produced is of a very good quality. The quantity of oxides formed amounts to from 2 to 3 per cent. of the lead operated upon, and the direct yield of lead is 82 per cent. of the base bullion treated. As only minute quantities of antimony are contained in the lead, dezincification is sufficient. The powdery mass on the metal surface consists, in 100 parts, of shots of lead 79 parts, of oxide mixture 21 parts.

100 parts of the oxide mixture contain: PbO, 61.4; ZnO, 30.8; the rest being iron, carbonic acid, &c.

At Lautenthal, and also at Tarnowitz, the old Pattinson plant is used for Parkes's process, and dezincification and refining are carried out in the same kettle. Owing to this arrangement, the inconveniences above mentioned sometimes occur at these works. At Lautenthal the steam is not superheated, but only dry, and has a pressure of only 14 pounds.

Experiments with superheated steam of higher pressure have not shown any advantages over the mode of operation practiced at Lautenthal. It was not possible, by increasing the pressure, to oxidize zinc and antimony at the same time, and, indeed, this would not have been advantageous.

After zinc and antimony have been removed, the lead is steamed for a third time at Lautenthal, and during this steaming the kettle is entirely uncovered; the oxides produced thereby are almost pure litharge. This third steaming has the object of assuring the perfect removal of antimony.

The direct yield of lead at Lautenthal is 80 to 84 per cent.; of zinciferous oxides 2.55 per cent.; and of antimonial oxides, 1.213 per cent.; (all calculated on the base bullion treated.) Of the lead (base-bullion) 1.14 per cent. passes into the zinciferous oxides, and 0.8 into the antimonial oxides. The zinciferous oxides contain 55 per cent. of lead. The removal of the zinc requires three hours, and that of antimony one hour.

The refined lead has the following composition:

Lead	99.9913
Copper	0.0022
Iron	0.0007
Antimony	0.0052
Zinc	......
Silver	0.0005

The treatment of the oxides formed in Cordurié's process now demands attention.

At Havre only zinciferous oxides are produced, which retain shots of lead. As we have seen, the powders formed during refining consist of 79 per cent. of shots of lead and 21 per cent. of oxides. These powders are washed with a little water on an inclined table, 6 feet long, which is divided into two compartments. The shots of lead remain on the upper compartment, and are returned to the refining process. On the second compartment oxides very rich in lead accumulate; these are reduced in a reverberatory furnace. The third product is a mixture containing approximately equal parts of oxide of lead and oxide of zinc; this passes through a sieve in the lower compartment of the table, and is collected in a reservoir. These oxides are subjected to decantation in barrels, hereby yielding two products: a mixture of oxides containing 60 per cent. of lead, and a mixture of oxides containing 30 per cent. of lead.

The first mixture is treated with hydrochloric acid, in order to extract the zinc; the residue is reduced in a reverberatory furnace. The second mixture is dried and sold as paint, (oxide of zinc.)

At Lautenthal three different kinds of oxide-mixtures are produced: zinciferous oxides, antimonial oxides, and oxides consisting mainly of oxide of lead.

The zinciferous oxides are washed on an inclined table, which has a sieve at the lower end. Two products are obtained: oxides with 80 per cent. of lead, which remain on the table, and oxides with 30 per cent. of lead, which pass through the sieve and are collected in old Pattinson kettles. The oxides with 80 per cent. of lead are passed through the blast-furnace in admixture with the impure oxides formed in the cupellation-process, scraps from ladling the refined lead from the kettles, oxides of the third class, (mainly of lead,) and slag. The lead hereby produced is refined by Cordurié's process, and brought into market as *Muldenblei*, (second quality lead.) The antimonial oxides are subjected to liquation in a reverberatory furnace, and yield lead, which is refined with the *Muldenblei*, and antimonial oxides, which are reduced to hard lead. The zinciferous oxides, containing 30 per cent. of lead, are sold as paint.

As already mentioned, impure lead of the Lower Harz was subjected to desilverization for a trial at Lautenthal in 1868. The desilverization was complete, but the refined lead produced was so impure as to make Parkes's process inapplicable. The advantages obtained in the Upper Harz by the adoption of Cordurié's process, led to a repetition of the trial. The refined lead obtained was greatly inclined to crystallization. It was not possible to prevent crystallization by casting the lead at a certain temperature. The lead was hard. As copper is entirely extracted from lead by zinc, and antimony is completely removed by steam, the peculiarities of the lead were ascribed to a considerable proportion of bismuth, which was detected by analysis made at Clausthal. The following table gives the results of the analysis:

Metals.	Refined Harz lead.	Lead obtained by desilverization and refining of base bullion of Julia-Hütte.	Lead produced from mixed ores of the Lower Harz, desilverized and refined.
Bismuth	0.007531	0.118031	0.352053
Copper	0.001243	traces.	0.000279
Antimony	0.004890	0.005149	0.002873
Iron	0.001408	0.003505	0.002877
Zinc	0.000257	0.000275	0.000573
Silver	0.000520	0.000700	0.000250
Total impurities, per cent	0.015849	0.127660	0.358904
Total lead, per cent	99.984171	99.872340	99.641096

The analysis of refined Harz lead is given for the sake of comparison.

A few words are necessary concerning the preliminary refining of lead which is to be subsequently subjected to desilverization by zinc.

A large proportion of antimony increases the consumption of zinc and influences unfavorably the process of desilverization by zinc. Lead containing much antimony must therefore be refined previous to desilverization. If the amount of antimony is not too large, refining is advantageously effected by Cordurié's process; otherwise the softening-process is preferable. The impure slag-lead of Andreasberg has been subjected to desilverization by zinc, and this trial has confirmed the general belief in the evil influence of antimony upon complete desilverization. Preliminary refining has been tried, with perfect success. The antimonial oxides (*Abstrich*) produced by preliminary refining contain some silver, a disadvantage which stands in no proportion to the advantages obtained by the new modification.

The process was conducted as follows: The lead was melted in a kettle, and after the dross which formed on the metal-surface, and which contained 10 per cent. of copper, had been removed, the temperature of the metal was raised and steam passed into it, in order to separate antimony. Steaming was carried on for 16 hours. In the softening-furnace it was possible to remove the antimony in the same time, but the antimonial oxides were too rich in silver. By refining in the softening-furnace, oxides containing 0.01 per cent. of silver were produced, and the cost per centner of lead was 3 sgr. 4.5 pf., or about 7.9 cents gold.

In refining by Cordurié's process the cost was only 3.1 cents, and the antimonial oxides contained but 0.0025 per cent. of silver.

The lead resulting from this refining was desilverized by 1.42 per cent. of zinc and subsequently dezincified by Cordurié's process. The desilverized and refined lead had the following composition:

	Per cent.
Copper	0.00476
Antimony	0.00317
Iron	0.00166
Zinc	0.00265
Silver	0.00060
Lead	99.98716

The amount of silver in the antimonial oxides is too small to make extraction profitable.

III.—TREATMENT OF THE ARGENTIFEROUS-ZINC ALLOY.

The high importance of Parkes's process has called forth among metallurgists, since the invention of that method, the eager endeavor to contribute to its improvement and fit it for more general use. Owing to a number of recent inventions, and to the extensive experiments made at large works, desilverization by zinc has been rapidly developed. The zincification of argentiferous lead and the refining of desilverized zinciferous lead have been highly improved, and are now very perfect operations. Only the last operation of Parkes's process—the treatment of the argentiferous zinc-crusts—was, until recently, attended with great difficulties, which the re-adoption of the distillation process will now doubtless remove. This was the first method used for freeing the argentiferous zinc-crusts from zinc. It was forsaken principally on account of the rapid corrosion of the distilling-apparatus by the lead. Mr. Gerhard, of the Friedrichshütte, at Tarnowitz, has recently prepared a lining for the muffles, which resists the corroding influence of the lead, and which answers its purpose fully. The preliminary experiments made with the distillation process at Tarnowitz have furnished results which justify great hopes.

The argentiferous-zinc crusts cannot be obtained free from lead; and although this may be partly removed by liquation, it is not practicable to such an extent, as to permit a direct separation of the silver from the dry zinc-crusts. The product finally obtained by the treatment of the argentiferous-zinc alloy always is rich lead, from which the silver is separated by cupellation. All methods considered in this chapter, therefore, only refer to the removal of zinc from the zinc-crusts.

The methods used for dezincification are very numerous. They effect the separation of zinc by oxidation and scorification, (Flach's process,) chlorination, oxidation, or distillation.

Of these methods none is now exclusively practiced. Flach's process was, for a long time, extensively practiced in Europe, and, although found very incomplete, it was retained because better methods were wanting. Dezincification by chlorination was only locally adopted. Other methods, such as dezincification by oxidation with litharge, have not met with success, and sensible improvement was only effected by the introduction of Cordurié's process. But this, also, has disadvantages, particularly the formation of large quantities of intermediate products, as will be seen below. Finally, as has been remarked above, the direct separation, by distillation, of argentiferous lead and zinc has been again taken up recently, and it is most likely that this process will replace all other methods of dezincification.

The liquation of the argentiferous-zinc crusts, in order to remove part of the lead, precedes their further treatment. The temperature used in this process (it is of course sensibly below the melting-point of zinc) must be carefully regulated, in case Cordurié's process is to be used for further treatment of the dry zinc-crusts. If the temperature during liquation is high, the zinc-crusts are too completely drained of lead; they are rendered too dry, and this causes the following disadvantages in the further treatment: First, the dry zinc-crusts only melt at a high temperature, the consequence of which is the formation of large quantities of rich oxides; and secondly, the formation of a rich alloy, containing silver, copper, and lead, is facilitated.

In general it will depend upon circumstances how liquation must be conducted. If, for instance, the base bullion, which is subjected to desilverization, is rich in copper, this will also be the case with the zinc-skimmings. By liquation at a high temperature the amount of copper in the rich lead finally produced is increased, and this causes large losses of silver in the cupellation process. The apparatus in which liquation may be carried out is a kettle, (most European works,) a reverberatory furnace, (old process at Tarnowitz,) or an iron pipe, (Llanelly Lead Works.)

Dezincification by oxidation and scorification.—In Flach's process the liquated zinc-alloy is passed through a blast-furnace, in addition with slag, at a low temperature and low pressure of blast. The zinc is oxidized and conveyed into the slag, and rich lead is produced, which is subjected to desilverization either directly or after previous refining. According to Sieger, higher pressure has been used without increasing the losses of metal. Sieger says, moreover, that in Flach's process the losses of silver and lead are less than by any other method, and that the silver extracted by that process exceeds by 2 per cent. the total indicated by assay. At German works this statement has not been confirmed, but long experience has established that this process involves large losses of silver. The process has doubtless many advantages; the operations are simple, cheap, and short; zinc of second quality may be used for desilverization; and the rich lead produced is relatively pure. Against these advantages the following disadvantages must be recorded: Large losses of silver are caused in the blast-furnace by the volatilization of zinc; the slags produced are highly zinciferous, and therefore bad to handle; and in them the zinc previously contained in the rich zinc-alloy is entirely lost. As the zinc-crusts require separate melting, an accumulation of that product is necessitated. This increases the cost at places where desilverization is not carried out on such a scale as to furnish sufficient material to keep the furnace in continual blast. In Germany Flach's process has been abandoned on account of the large losses of silver and the formation of intermediate products difficult to handle. At Tarnowitz the process was retained after Cordurié's had been substituted for it at all other Prussian works. The cause of this will be seen below. In the spring of 1873 I saw Flach's process yet in operation at Tarnowitz, but since that time it has been replaced by the distillation process.

Flach's process was carried out at Tarnowitz in the following manner: The zinc-skimmings were liquated in the cupelling-furnace, hereby producing poor lead and rich oxides, consisting of a mixture of metallic particles and of the oxides of lead and zinc. The liquated lead was subjected to partial cupellation in order to concentrate the contents of silver. The resulting concentrate-lead (*Concentrationsblei*) was completely cupelled when a sufficient quantity of it had accumulated. The rich oxides were passed through the blast-furnace, together with double the amount of tap-cinder, containing at most 0.5 per cent. of lead. The products of smelting were: First, argentiferous lead, with 1.821 per cent. of silver, (531.124 ounces per ton;) second, slag, with 0.3 per cent. of lead and 0.01 per cent. of silver, (2.9166 ounces per ton;) third, a zinciferous product, (*Ofenbruch*,) containing 67 per cent. of zinc, 10 per cent. of lead, and 0.5 per cent. (145.833 ounces) of silver.

The charge consisted of liquated zinc-skimmings and 200 per cent. of tap-cinder; the consumption of fuel was 82.34 per cent., (that is, 82.34 pounds coke for 1 centner = 100 pounds of charge.) In smelting 1,853.36 centner of the rich zinc-skimmings with 3,649 centner of tap-cinder, and 763 centner of coke, the following quantities of the products already mentioned were obtained: 1,420 centner of rich lead, 3,000 centner of pure slag, and 58.50 centner of the zinciferous product, besides 675 centner of impure slag. The cost of the treatment per centner of the zinc-skimmings was 3 sgr. 4.5 pf. = 7.9 cents gold.

The *Ofenbruch* was subjected to distillation at Bleiberg for a trial, but the process was wrecked by the corroding influence of the lead upon the muffles, and the formation of an alloy, consisting of zinc, silver, and lead, which was more difficult to handle than the original substance.

At Call Flach's process is applied to the impure (first) skimmings, in which copper and gold are concentrated. These skimmings are passed through the blast-furnace, together with the residues from the treatment of the argentiferous zinc-crusts, and with slag consisting of silicate of protoxide of iron, lime, and alumina. The argentiferous residues added to the charge contain 8 to 10 per cent. of lead, and this contains 2.7 per cent. (787.498 ounces) of silver. The products are lead with 0.7 to 0.8 per cent. (204.166 to 233.333 ounces) of silver and argentiferous slag, which is added to ore-smelting. The lead produced by this process is very pure, and owing to this the process has been retained, although it involves large losses of silver.

The argentiferous and auriferous lead is again treated with zinc, and then dezincified by chlorination, as will be seen below. The rich lead finally obtained is cupelled, and yields silver with 0.1 per cent. (29.166 ounces) of gold.

Dezincification by chlorination.—In this process the dezincification of argentiferous zinc-scum is carried out in a manner similar to the dezincification of zinciferous lead by chlorination. The process is characterized by low temperatures and slow reactions.

At Braubach, where this process was once in use, the chlorination of zinc was effected by chloride of lead, which was mixed into the molten lead at a dull-red heat. The resulting lead was cupelled, and the chloride of slag, which retained shots of lead, was passed through the blast-furnace.

At Call the dezincification is still effected by chlorination. It is claimed that the losses of metal are very small, owing to the low temperature used in the process. A disadvantage of this process is its long duration, which would be very serious in the case of a large production.

The manner of conducting it at this place is as follows:

Only those skimmings are treated by this process which are taken off the lead after the impure auriferous skimmings have been removed. The auriferous skimmings would yield a very impure lead, if treated by the chlorination process, and this lead would render the cupellation process very difficult. It has been found that lead containing gold and copper at the same time is disposed to form, during cupellation, an alloy consisting of gold, copper, and lead, which separates in lumps, and which requires a very high temperature for fusion. The impure skimmings are, therefore, treated by Flach's process, which yields a very pure lead.

The pure skimmings are treated with a mixture of carnallite ($2MgCl+KCl+12Aq$) of *Stassfurth*, and chloride of ammonium, at about 400° C. The quantities operated with are: 30 centner of dry zinc-crusts, 9 centner of carnallite, and 3 centner of chloride of ammonium. Two products are obtained: 26 centner of rich lead, which is tapped, and melted chloride, which is yet argentiferous. From 5 to 6 centner of lead, containing 0.01 per cent. (2.9166 ounces) of silver is now added, in order to extract the silver from the chloride-slag. After the ingredients have been melted together, the lead (about 4 centner) is tapped and added to the lead of the first tap, which has been kept fluid in a separate kettle. Thus 30 centner of rich lead are produced, and this contains 2.7 per cent. (787.498 ounces) of silver. The residue in the kettle is treated as described above. The lead which was added to the chloride-slag after the first tap had been drained from the argentiferous zinc-skimmings. The duration of the operation is three days. The process is said to work very nicely. It has not been introduced at any other works.

Dezincification by oxidation.—Under this head are included two general methods, characterized respectively by the employment of litharge and of steam as the oxidizing agent.

At the Tyne Lead Works, near Newcastle, Roswag effected oxidation of the zinc by adding the dry zinc-crusts in the cupellation process. The intention was to oxidize the zinc by the litharge formed during cupellation, and to concentrate the silver in the lead. The resulting lead, which contained 2 to 3 per cent. (583.33 to 874.998 ounces) of silver, was cupelled in a separate furnace. This process necessarily caused large losses of silver.

In the Harz, trials were made with a view to use litharge for the oxidation [illegible] the zinc in the zinc-crusts in a manner similar to the dezincification [illegible] zinciferous lead, as conducted at Commern.

Equal parts of the argentiferous zinc-alloy and litharge were used. The process was carried out in a reverberatory furnace, and was so conducted that the litharge covered the alloy. The influence of the litharge upon the argentiferous zinc-alloy was trifling. On freeing the metal from its cover violent burning of the zinc took place, which caused large losses of metal. After all zinc had been oxidized in this way the temperature was raised; but it was impossible to melt the oxidés, even at the highest temperature attainable, and hence the oxides were removed in a semi-fluid condition. The skimmings, the quantity of which amounted to 42 per cent. by weight, of the charge (argentiferous alloy and litharge)—contained considerable quantities of shots of lead, and 0.5 to 1 per cent. (145.83 to 291.67 ounces*) of silver. Cupellation went on in the regular way after the removal of the oxides, the litharge produced (39 per cent. of the charge) containing 0.0079 per cent. (2.304 ounces) of silver. The fumes from the litharge-channel contained 0.06 per cent. (17.5 ounces,) and from the chimney 0.01 per cent. (2.9167 ounces) of silver.

From one-quarter to one-third of the charge always remained on the surface of the lead unfused. This infusible residue contained 2 to 3 per cent. (583.33 to 874.998 ounces) of silver.

When the process was tried in open kettles the results obtained were equally unfavorable.

The process was a perfect failure, on account of the infusibility of the zinc-skimmings, and because the proportion of litharge and zinc was not large enough.

Dezincification by steam (Cordurié's process) is based upon the fact that steam is decomposed by zinc at a high temperature. Complete dezincification is effected by this process, and in a short time; but an oxide-mixture is produced, from which the very large contents of silver can only be extracted by a number of incomplete and costly operations. The quantity of oxides formed amounts to about one-third to one-half of the argentiferous lead produced. Although these are serious disadvantages, the process has, nevertheless, been advantageously substituted for Flach's and other methods.

The process is carried out as follows:

The argentiferous zinc-alloy is melted in a kettle, and this covered with a hood, whereupon the temperature of the metal is raised to yellow heat, which renders it semi-fluid. Steam is now passed through the metal (after the conveying pipes have been freed from water) and is hereby decomposed, oxidizing zinc at the same time, whereby the temperature of the metal is rapidly increased.

Owing to the large amount of zinc in the metal, the gases evolved by dezincification are highly charged with hydrogen, and therefore very explosive. In order to prevent explosions the hood must fit well to the kettle, all openings in the hood must be carefully luted, and a jet of steam must be blown through the hood and through the condensing-chamber before passing steam into the metal. The hood must be connected with extensive condensing-chambers, since large quantities of powder are carried away, owing to the violent evolution of hydrogen. During the process, it is necessary to beat the hood repeatedly with a piece of timber, in order to loosen the powders which settle on the inside surface.

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* The ounces of silver thus given in parenthesis refer throughout this chapter to ounces troy per ton of 2,000 pounds avoirdupois.—R. W. R.

Steaming must be continued until the oxides formed during the process are quite dry and all zinc is removed. If a sample of the oxides exposed to free access of the air shows burning of zinc, dezincification is not completed. Before removing the hood steam must again be passed through the hood and the condensing-chambers. If the condensing-chambers are extensive enough, there is no fear of large losses in silver.

Cordurié's process is also used at Havre. Here the zinc-skimmings are liquated in small kettles at a high temperature, and the resulting skimmings, which contain 2½ to 3 per cent. (729.165 to 874.998 ounces) of silver are taken off very dry; the liquated lead is returned to the desilverizing-kettle. The argentiferous zinc-skimmings are treated with superheated steam of 60 to 70 pounds pressure, at a yellow heat. Experiments in the Upper Harz have established that the same results can be obtained with dry steam (not superheated) of only 14 pounds pressure.

At Havre an alloy containing 9 per cent. of copper and silver is formed by the projection of metallic particles against the head. Part of the lead contained in these metallic particles, which stick to the head, is liquated and the infusible alloy remains behind. The richness of the oxides formed in Havre is partly due to intermingled lead shots of this alloy. At Havre the products of dezincification are rich oxides and rich lead.

The time for completion of the process is four hours.

Owing to the small amount of lead left in the zinc-crusts the oxides produced by steaming are richer in silver than the rich lead.

In a series of experiments on a large scale, made at Havre, a loss of 3 per cent. of silver was determined; and this loss was found to be due to insufficient condensing-chambers. At Havre the rich lead is cupelled, and the oxides are treated with hydrochloric acid, as will be seen below.

In the Harz, where Cordurié's process has replaced that of Flach, the argentiferous zinc-alloy is liquated in a Pattinson kettle at a low temperature. The dry skimmings contain 1.5 per cent. (437.5 ounces) of silver. The resulting lead is desilverized in the same kettle (after the argentiferous zinc-crusts have been removed) simply by skimming; or, if necessary, by the addition of a small quantity of fresh zinc. This method is more economical than that practiced at Havre.

The products of dezincification in the Harz are 70 to 75 per cent. (of the zinc-crusts) of rich lead, with 1.5 to 1.75 per cent. (437.5 to 510.416 ounces) of silver; 32 to 35 per cent. of oxides with 0.5 to 1 per cent. (145.833 to 291.667 ounces) of silver. It appears, therefore, that the oxides are poorer in silver than the rich lead. This is, as already stated, owing to the larger amount of lead (55 per cent.) left in the zinc-crusts.

In the Harz, 100 centner of zinc-skimmings are dezincified in four hours by dry steam of 14 pounds pressure. This is also the duration of the process at Havre, where superheated steam of high pressure is used. In the Harz the kettles have not been renewed during a campaign of four months, whereas at Havre they are rapidly destroyed.

The treatment of the oxides produced in Cordurié's process at Havre is as follows: The powders formed by dezincification of the zinc-crusts are sifted. The metallic shots remaining in the sieve are pounded and added to the sifted oxides. The whole mass is hereupon treated with cold hydrochloric acid in large basins. The zinc is thus extracted as chloride of zinc; chloride of silver and oxychloride of lead remain behind. The complete removal of the zinc is determined by a test made of the residue on a scarifier in the muffle. Zinc is completely extracted if the mass on the scarifier fuses easily, and separates into a metallic button and slag, both of which are well fused. Zinc is not completely extracted if the slag (chloride) is not well fused, and retains shots of metal. By dipping a strip of zinc into the solution, it can easily be determined whether this contains sufficient acid, or whether acid is lacking. In the former case hydrogen is evolved.

If the test in the muffle indicates the completion of the process, and a strip of zinc dipped into the solution causes the evolution of hydrogen, oxides must be added, as there is then an excess of acid. If both tests give the reverse indications, acid must be added. The process of extraction completed, the solution is drawn off into basins. The residue, consisting of metallic particles, chloride of silver, chloride and oxychloride of lead, and oxychloride of antimony, is drained, and then melted in a cast-iron kettle, yielding lead and melted chloride. The lead is cupelled, and the chloride is reduced in a reverberatory furnace in admixture with coal and lime. The lead resulting herefrom is returned to desilverization, the slag (chloride) is passed through the blast-furnace with plumbiferous matter (from the reduction of antimonial litharge, &c., see below,) and slag, consisting of silicate of protoxide of iron, lime, and alumina. The products are: matte containing copper and little lead; and hard lead, which is refined, producing soft lead and antimonial oxides. The soft lead is returned to desilverization; the oxides (*Gekrätz*) are reduced, forming hard lead, which is marketable, and antimonial oxides, which are passed through the blast-furnace, in admixture with other intermediate products. A scheme of this complicated process is given below. The solution of chloride of zinc was formerly thrown away, but at present the zinc is precipitated out of it by carbonate of lime, and the precipitate is sold as paint, (oxide of zinc.)

In the Harz, the rich oxides are added to the lead in the cupellation-furnace in quantities of 3.5 to 4 centner. The blast is turned off until the oxides have attained a pasty consistency, when it is again put on and the fire is urged. Silver is hereby conveyed into the lead, and an imperfectly-melted oxide mixture is obtained, (*Abzug*,) which is drawn off. The *Abzug* contains about 0.15 per cent. (43.75 ounces) of silver, and is reduced in the blast-furnace, together with the litharge formed in cupellation. The process of adding the rich oxides to the rich lead is termed *Eintränkarbeit*. It is advantageous to have a certain proportion of oxides and lead in the *Eintränkarbeit*. In order not to have too large a quantity of oxides in this process it is necessary not to take off the zinc-crusts too dry. In this respect it has been found profitable at Lautenthal to make the quantity of dry zinc-crusts from 8 to 10 per cent. of the base bullion subjected to desilverization. The cupellation-furnace must be connected with the condensing-chambers, in case of which there is no fear of large losses of silver. At Lautenthal, where this process is carried out, the managers are well aware of its incompleteness; but as it has given better results than any of the other methods tried at the works, it has been retained. The great disadvantage of this process is the large quantity of argentiferous products, which are, on account of their contents of zinc, difficult to handle. The zinc previously contained in the zinc-crusts is entirely lost in this process.

Trials have been made with a view of separating the shots of lead from the oxides by levigation; no complete separation was effected, as the oxide of zinc obtained was too rich in silver to be thrown away.

At Tarnowitz, Cordurié's process did not give satisfactory results, on account of the purity of the argentiferous zinc-crusts, which increased the oxidation of lead along with zinc. By adding salt to the argentiferous zinc alloy during steaming, the quantity of oxides was reduced to one-third; but this was still too much for the *Eintränkarbeit.* From 120 centner of argentiferous zinc-crusts 58 centner of dry zinc-skimmings were obtained. To these skimmings 3 centner of salt were added, and thereupon steam was passed into the metal. The result was 34.45 centner of lead, containing 1.323 per cent. (385.874 ounces) of silver, and 27.05 centner of oxides. This quantity of oxides is too large for Tarnowitz, as not enough argentiferous lead is produced at that place to give the necessary proportion in the *Eintränkarbeit.*

Dezincification by distillation.—This is the most direct method for the treatment of the argentiferous zinc-crusts, since only two products are obtained: zinc, which is again used for desilverization, and rich lead, which is cupelled. The process involves no losses of silver; as all the silver which may have been volatilized is collected in the zinc, and is brought back to desilverization. Distillation is carried out in short time, and does not require much labor.

At the Llanelly Lead-Works distillation was first used for dezincification of the argentiferous zinc-crusts. The process was here carried out in Belgian retorts. The charge of one furnace consisted of 5 hundredweight of the argentiferous alloy with its own bulk of coal, and twice its bulk of lime. Rich lead and pulverulent matter were produced; the former was cupelled, and the latter was added in ore-smelting. The duration of the process was twenty-four hours; there are large losses of zinc throughout the process.

At Pise, the argentiferous zinc-crusts are heated in crucibles. The zinc is thereby volatilized and lost; the residual lead is cupelled. This method is very incomplete, and must necessarily cause large losses of silver.

Recently a series of experiments on a large scale was made at Tarnowitz, with a view to effect direct removal of the zinc from the zinc-crusts. For this purpose zinc-crusts were mixed with salt and carbonaceous matter in one instance, and with carbonaceous matter alone in the other. The mixture was heated in a crucible of cast iron, which was destroyed so rapidly as to make the process impracticable for this reason alone. The nature of the mixture had no influence upon the production; but the first mixture was not so corrosive as the other. Rich lead and unmelted residue were the products of this process. As the yield in this method was 63.25 per cent. of rich lead, against a yield of 85.38 per cent. in Flach's process, the former was also disadvantageous in this regard.

In a second series of experiments the charge was heated in black-lead crucibles, and a continuous process was contemplated, for which purpose a pipe was inserted into the crucible, through the bottom. The results of these experiments were not satisfactory. The charge consisted of argentiferous zinc-crusts mixed with 3 to 5 per cent. of coal-dust. In the beginning of the operation the lead was only separated slowly, and contained no more than 0.42 per cent. of silver, (122.5 ounces,) which, however, increased, and finally amounted to 0.8 per cent. (233.333 ounces) of silver. After the lead was removed, an alloy was separated which was rich in copper, and contained 1.3 to 1.61 per cent. (379.166 to 469.58 ounces) of silver. This alloy, dropping down, soon closed the tap, and consequently interrupted the process. It was never possible to treat more than 2 centner of zinc-skimmings without interruption. The following products were obtained by this process from 2 centner of rich zinc-crusts: First, 1.08 centner of rich lead with 0.42 to 0.8 per cent. (122.5 to 233.333 ounces) of silver; and 0.28 centner of the alloy with 81 per cent. of lead and 1.3 to 1.61 per cent. (379.166 to 469.58 ounces) of silver; secondly, 0.5 centner of unmelted residue with average contents of 1.33 per cent. (387.916 ounces) of silver. The volatilization of zinc, therefore, did not exceed 7 per cent.

It was now suggested to carry out the operations of liquation and of distillation separately, as it was impossible to obtain satisfactory results by the method used in the experiments described. The new modification of the process ran as follows:

Liquation was performed in cylindrical crucibles of wrought iron, 0.85 feet in diameter and 1.7 feet in height, and the iron was about 1 inch thick. One crucible endured 100 fusions. Black-lead crucibles were found to be inferior to those of wrought iron. The zinc-skimmings were charged in pieces of the size of peas, and mixed with salt, which was "denaturalized" by admixture of 5 per cent. of kieserite, (MgO, SO_3, Aq.) The crucible was subjected to a strong heat, and, after the bottom had been covered with a thin layer of charcoal, the mixture was charged. The charge was also covered with charcoal. These experiments established that eight crucibles were equivalent to one blast-furnace; and, moreover, the wrought-iron crucibles were found to fully answer their purpose. Of the zinc-crusts treated, 59 per cent. in rich lead was obtained, which corresponds to 75 per cent. of the amount of lead contained in the material. The remaining 25 per cent. of the lead was contained in the zinciferous residue, which was very rich in silver. The losses of metal were low.

The zinciferous residue was then subjected to distillation in a cast-steel crucible for a trial. After white heat had been applied for 7 hours, the operation was interrupted, and the following products were obtained: zinc, containing, 1.25 per cent. of lead, 0.03 per cent. of cadmium, 0.19 per cent. of carbon, 0.00012 per cent. of silver; and lead, remaining behind in the crucible. This lead contained 4 per cent. of silver. The favorable results of the foregoing experiments led to a repetition of the trial; but distillation was this time carried out in a muffle. The muffle was furnished with a lining of brasque, consisting of 4 parts of cinder and 1 part of clay. The charge of one muffle was 0.5 centner, and consisted of the argentiferous alloy mixed with 30 per cent. of cinder. The products from 2 centner of rich residue were 30.2 to 36.2 per cent. of rich lead, containing 3.52 to 4.01 per cent. (1026.66 to 1169.58 ounces) of silver; and 18.8 to 23 per cent. of crude zinc, containing very little silver. Moreover, 8.7 to 16.2 per cent. of lead with 2.5 to 3.47 per cent. (729.165 to 1012.08 ounces) of silver, were obtained in sifting the pulverulent residue of distillation.

This process has been recently introduced at Tarnowitz, but no results have yet been published. The apparatus used at Tarnowitz is a Silesian zinc-oven in its essential features. It has twenty-four muffles and is heated by generator-gases. The air necessary for combustion is furnished by a blast-machine, and enters the oven after it has passed a heating-apparatus, which is located in the flue. The lining of the muffles is prepared as follows; Sifted cinder is treated with dilute acid, then heated, and then treated with alkaline salts, in order to make it capable of agglutinating with the clay of the muffles. After the cinder has been fixed to the muffle, the lining is furnished with a glaze made of lead-fume and clay.

IV.—RESULTS OF DESILVERIZATION BY ZINC AT LAUTENTHAL, HAVRE, AND CALL.

Lautenthal.—At Lautenthal, the old Pattinson kettles are used for Parkes's process. Two kettles are in continual operation for desilverization and refining, both operations being carried out in the same kettle. The charge for desilverization is 250 centner of argentiferous lead.

Between the two desilverization-kettles stands a kettle, in which the second and third skimmings of the former are subjected to liquation. The process of liquation is carried out simultaneously with desilverization; that is, it is not commenced only after sufficient quantity (second and third skimmings of second charges of both kettles) has accumulated; but gradually, as the rich skimmings are taken off and are thrown into the liquation-kettle. The dry zinc-skimmings are cast into molds, and when a sufficient quantity is at hand they are dezincified by steam in a separate kettle. The liquated lead is completely desilverized in the same kettle, either by skimming alone, or by the addition of a small quantity of fresh zinc. The auriferous skimmings are treated separately; but in a manner similar to the treatment of the second and third skimmings. The steam used for dezincification and refining is dried by passing through a winding pipe, heated in a small oven.

Desilverization (melting of the base bullion and ladling of the refined lead included) requires twenty to twenty-four hours, and 500 centner of argentiferous lead are desilverized in this time. The lead treated contains 0.13 to 0.14 per cent. of silver (37.9166 to 40.833 ounces) and 0.285 per cent. of Cu, 0.003 per cent. of Fe, and 0.442 per cent. of Sb. The desilverized lead contains 0.0004 to 0.0005 per cent. (0.1966 to 0.1458 ounces) of silver.

In twelve hours five laborers are employed, four attending to the two desilverization-kettles, and one as fireman. Moreover, one man is employed, who attends to the boiler, and who conducts the refining of the lead and the dezincification of the rich zinc-crusts.

The different operation of the process and the special results are given the annexed table and scheme, which are taken from the essay of Drs. Wedding and Bräuning in the *Preuss. Ztschr. für Berg-Hütten- u. Salinenwesen* 1869, vol. 17.

In the same essay the economical results of the process are given as follows:

German moneys I have converted into United States coin at the rate of 42.5 gr. to $1 gold.

Costs for desilverization and refining of 1 *ton* (2,000 *pounds German*) *of base bullion.*

Labor	$0 36
Zinc	1 41
Fuel	55
	2 32

The losses of metal and general costs are not taken into consideration. The total costs for the treatment of 1 ton of base bullion are given as $4.43.

As we have already seen, 82 to 84 per cent. of refined Harz lead is directly produced.

From the whole amount of lead brought into the process, this yields 97.024 per cent., showing a loss of 2.976 per cent.

Results obtained in treating 15,051 *centner of base bullion of the Upper Harz.*

[One centner = 50 kilograms; 20 centner = one metric ton; one Pfundtheil, (symbol, lbth,) = .01 pound.]

Materials and products.	Desilverization.				Refining by Cordurié's process.		Refining with salts of Stassfurth.	Refining by poling.
	Contents of metal indicated by assay.				Per cent. of metal contained in the material, and yield per cent.		Per cent. of metal contained in the material, and yield per cent.	
	Silver.		Lead.		Silver.	Lead.	Lead.	Lead.
	Lbs.	*Lbth.*	*Ctr.*	*Lbs.*				
I. MATERIALS.								
15,000 centner of base bullion from one smelting, (Schliechschmelzen)	2,068	4.90	14,979	32	....	....	....	....
51 centner of base bullion from liquation of antimonial litharge, (Abstrich)	5	1.00	50	95	....	....	....	....
Sum total	2,073	5.9	15,030	27	100	100	100	100
II. PRODUCTS.								
A.—Marketable products:								
2,173.17 pounds of Blicksilber	2,031	9.1	....	......	97.90	....	....	....
Raffinirtes Harzblei, (first quality lead)	....	....	12,505	54	....	83.302	77.187	74.57
Gutes Muldenblei, (second quality lead)	....	....	833	20	....	5.543	12.120	15.40
Hard lead	....	....	200	19	....	1.332		
Silver-free oxides, with 30 per cent. of lead, (123 centner.)	....	....	36	90	....	0.246		
Sum A	2,031	9.1	13,575	83	97.90	90.423	89.307	89.97
B.—Intermediate products which are returned to smelting:								
462 centner Abzug, with .09 per cent. of silver	41	5.8	461	59	....	....	....	....
157 centner buttons of .01 per cent. of silver and 66 per cent. of lead, cupellation-furnace	1	5.7	103	96	....	....	....	....
324 centner plumbiferous matter, with .005 per cent. of silver and 90 per cent. of lead	1	6.2	291	60	....	....	....	....
110 centner lead-scraps, with 94 per cent. of lead	....	....	103	40	....	....	....	....
333 centner lead-slag, with 74 per cent. of lead	....	....	46	62	....	....	....	....
Sum B	43	17.7	1,007	17	2.150	6.701	7.373	6.87
Sum total, (A and B)	2,074	26.8	14,582	......	100.050	97.024	96.680	96.84
Product of metal, as compared with assay { more	3	0.9	....	......	0.149			
Product of metal, as compared with assay { less	....	....	447	27	....	2.976	3.320	3.16

SCHEME OF PROCESSES AT LAUTENTHAL.

The figures in [ ] are percentages of the amount of base bullion treated, in this case 15,051 centner or 7,525.5 kilograms. Final products are printed in small caps; German terms in italics.

- 1. Base bullion. treated with [1.48] zinc.
  - 2. Desilverized lead. (Treated with steam.)
    - 5. [2.553] silver-free oxides, containing 50 to 60 per cent. Pb. (Washed on inclined table.)
      - 7. [1.733] oxides, containing 80 per cent. Pb. (Reduced with 0.64 ctr. coke.)
        - 9. [0.426] plumbiferous residue. (*Bleidreck*, added in blast-furnace.)
        - 10. [6.713] poor lead. (Refined by steam.)
          - 11. [5.55] *gutes Muldenblei.* (SECOND QUALITY LEAD.)
          - 12. [0.533] *Abzug.* (Added to matte-smelting.)
          - 13. [0.373] *Abstrich.* (Reduced with 0.567 ctr. coke.)
          - 14. [0.307] plumbiferous refuse. (*Bleidreck*, added in blast-furnaces.)
            - 15. [1.334] HARD LEAD.
      - 8. [0.82] oxides, containing 30 per cent. Pb. PAINT.
    - 6. Impure lead. (Treated with steam, doors open.)
      - 16. [83.202] SOFT LEAD.
      - 17. [1.213] antimonial oxides and [2 273] lead scraps, (added to No. 7.)
  - 3. Dross. (Liquated.)
    - 18. [3.07] residue. (Subjected to matte-smelting.)
    - 19. Soft lead. (Returned to desilverization.)
  - 4. Rich zinc crusts. (Liquated.)
    - 20. Argentiferous lead. (Desilverized separately.)
    - 21. [8.297] dry zinc crusts. (Treated with steam.)
      - 22. [5.88] rich lead. (Cupelled.)
        - 24. Antimonial oxides. (*Abzug*, added to No. 26.)
        - 25. Pure and rich lead. (Cupelled.)
          - 26. Argentiferous *Abstrich.* (Reduced.)
            - 30. [6.7] argentiferous lead. (Cupelled.)
              - 31. Rich lead. (Added to No. 22.)
              - 32. *Abstrich* and litharge. (Added to No. 7.)
          - 27. Plumbiferous products, such as bottoms of cupelling furnace, &c. (Added to No. 26.)
          - 28. Litharge. (Added to No. 26.)
          - 29. BLICKSILBER. (Refined.)
      - 23. [2.36] argentiferous oxides. (Added in the cupellation-furnace to No. 5.)

Havre.—The plan of the works at Havre, as projected by Cordurié, is given in the annexed drawing. At Havre, however, it proved not possible to place the desilverization-kettle higher than the dezincification-kettle. In the drawing the different parts are lettered as follows:

Fig. 1:

u, vertical shaft, with perforated box *a* and agitator *b* put in rotation by means of handle *c* and cog-wheels *b'*.

k, lid of the perforated box, held in place by the wedges *l*.

e, carriage on which rests the apparatus.

h, wedge opposed to buoyancy of the apparatus.

Fig. 4:

a, desilverization-kettle.

b, liquation-kettle.

d, refining kettle.

g, condensing-chamber.

q, valve which is opened before steaming in order to blow out the water which may have been condensed in the conveying-pipes.

Fig. 3:

a, desilverization kettle.

b, inverted discharging-pipe.

c, trough through which the tapped lead flows into the refining-kettles.

m, (also Fig. 5,) plug for closing the tap.

n, steam-conveying pipe, which passes through the flue *p*, in which the steam is superheated.

A desilverization-kettle holds 200 centner of argentiferous lead. Desilverization (melting of the argentiferous lead and ladling of the refined lead from the kettles) requires twenty to twenty-four hours.

Zinc is added in three portions, and the consumption of zinc amounts to 1 per cent. The desilverization-kettles are always in operation, and therefore 2 charges or 400 centner of argentiferous lead are treated in twenty-four hours.

The base bullion treated at Havre contains 0.04 to 0.06 per cent. (11.66 to 17.5 ounces) of silver, and the desilverized lead contains 0.0005 per cent. (0.1458 ounces) of silver. There are three laborers employed in twelve hours, of whom two attend to the desilverization kettles, the other attends to the boiler and conducts dezincification and refining. Ladling is done by other workmen, &c.

In a paper by Prof. M. L. Gruner, (*Annales des Mines, tome* 13, *sér.* 6, 3 *livre*, 1868,) the costs of the process at Havre are given as follows for the treatment of 1 ton (2,000 pounds German) of base bullion:

Labor (20 men for the treatment of 20 tons of base-bullion) and laborer	$0 75
Coal, 2 centner, (100 kilograms)	0 47
Zinc, 0.2 centner, (10 kilograms)	1 05
Loss of lead, 0.2 centner, (10 kilograms)	0 87
Hydrochloric acid, 0.4 centner, (20 kilograms)	0 19
	3 33

All other costs, such as costs for maintenance of the apparatus, for cupelling, &c., added to this will make a total cost of $3.76 to $4.70 per ton of base bullion.

SCHEME OF PROCESSES AT HAVRE.

Final products are printed in small caps; German terms in italics. Figures in [ ] indicate percentage of the amount of base bullion treated.

- 1. Base bullion, (treated with 1 per cent. Zn.)
  - 2. Desilverized lead, containing Ag. 0.0005 per cent.; Zn. 0.75 percent. (Treated with steam.)
    - 4. Silver-free powder, consisting of 21 per cent. oxides and 79 per cent. shots of lead. (Washed.)
      - 6. Shots of lead. (Added to No. 2.)
      - 7. Oxides rich in lead. (Reduced in reverberatory-furnaces.)
        - 9. Impure lead. (Added to No. 2.)
        - 10. *Abstrich.* (Added to No. 26.)
      - 8. Mixture of zinc and lead oxides. (Subjected to decantation.)
        - 11. Zinciferous oxide of lead. (Added to No. 15.)
        - 12. OXIDE OF ZINC. (Paint.)
    - 5. [82] SOFT LEAD.
  - 3. Rich zinc-crusts. (Subjected to liquation.)
    - 13. Dry zinc-crusts. (Treated with steam.)
      - 15. Rich oxides. (Treated with H Cl.)
        - 17. Chloride of zinc solution. (Precipitated with carbonate of lime.)
          - 21. OXIDE OF ZINC.
        - 18. Residue. (Melted in a kettle.)
          - 22. Melted chloride. (Treated in the reverberatory with lime and carbonaceous matter.)
            - 26. Chloride-slag. (Passed through a low blast-furnace.)
              - 28. Matte, containing copper. (Added to No. 20.)
              - 29. Hard lead. (Refined with steam.)
                - 30. Argentiferous soft lead. (Added to No. 1.)
                - 31. Antimonial oxides. (Reduced, yielding—
                  32. HARD LEAD, and,
                  33. *Abstrich*, to be added to No. 26.
            - 27. Argentiferous lead. (Added to No. 1.)
          - 23. Rich lead. (Added to No. 16.)
      - 16. Rich lead. (Cupelled.)
        - 19. SILVER.
        - 20. Rich litharge. (Reduced.)
          - 24. *Abstrich.* (Added to No. 26.)
          - 25. Rich lead. (Added to No. 16.)
    - 14. Liquated lead. (Returned to No. 1.)

At Call four kettles are in continual operation; three for desilverization of the argentiferous lead and refining of the desilverized lead, and one for the treatment of the argentiferous zinc-crusts. Two kettles beside the four are used alternately for liquation of the rich zinc-crusts and for refining of hard lead. The first kettle is in use one day in every five, and the other one day in every thirty.

The desilverization-kettles have a diameter of 8.27 feet, (English,) and are 1.97 feet deep. The argentiferous lead taken for treatment contains 0.05 per cent. (14,583 ounces) of silver, and 0.5 per cent. of antimony, and 0.01 per cent. of copper, some iron, and traces of gold. The refined lead contains 0.0002 per cent. (0.0583 ounces) of silver. Twelve tons (of 2,000 pounds German) are treated in twenty-four hours, employing six laborers, four melters, and two firemen. One ton of base bullion does not yield more than 0.6 centner (3 per cent.) of rich lead for cupellation.

The direct product of refined lead is about 90 per cent.

The cost of the treatment of 1 ton of argentiferous lead is given by Zeiller & Henry (*Annales des Mines, tome xviii*, 3 *livre de* 1870) as follows:

In order to completely work off 1 ton of base bullion, 2,200 pounds German, of metal, must be subjected to desilverization, and 880 pounds of rich liquated zinc-crusts are treated. The material used is:

30.4 pounds (15.2 kilograms) zinc	$1 60
7.2 pounds common salt	03
17.6 pounds carnallite	06
3.0 pounds chloride of ammonia	28
	1 97

As 1 kettle uses 800 pounds of coal in twenty-four hours, the consumption for all kettles is: $800 (4 + \frac{1}{5} + \frac{1}{30}) = 3{,}387$ pounds (for twelve tons) treated in twenty-four hours.

For the treatment of one ton, therefore, 282 pounds of coal are consumed, the price of which is $0.66.

The total costs are, therefore:

Labor	$0 26
Zinc and reagents	1 97
Fuel	66
Total	2 89

If the loss of lead, (30 pounds per ton,) or 1.5 per cent., is taken into consideration, the costs become:

$2 89
1 11
4 00

The cost of treating the first skimmings and the intermediate products in the blast-furnace is not included.

SCHEME OF PROCESSES AT CALL.

Final products are printed in small caps; German terms in italics. One centner (ctr.) equals 100 pounds German, or 50 kilograms, very nearly.

- 1. Argentiferous lead; charge of kettle, 15 tons, or 30,000 pounds German.
  - *a*. After the addition of 1.8 ctr. Zn., No. 2 is removed.
  - *b*. After removing No. 2 1 ctr. Zn. is added, and, after skimming, 26 ctr. lead from No. 7 is added, as well as the last portion of Zn., 1.34 ctr.
    - 2. Auriferous skimmings, 10 ctr. (To the blast-furnace, with slag and No. 12.)
      - 5. Argentiferous slag. (Added in ore-smelting.)
      - 6. Lead, containing 0.7 to 0.8 per cent. silver. (Desilverized yields silver containing 0.1 per cent. gold.)
    - 3. Argentiferous skimmings, 60 ctr. (Liquated.)
      - 7. Lead, with 0.01 per cent. silver. (Of this lead 26 ctr. is added to No. 1, *b*, and 5 to 6 ctr. to No. 9.)
      - 8. Dry skimmings, 8 ctr., containing 2 to 3 per cent. silver. (Of this, 30 ctr. is treated 3 days at 400° C., with 9 ctr. carnallite and 3 ctr. NH_4Cl.)
        - 9. Chloride-slag. (Treated with 5 to 6 ctr. of liquated lead from No. 7.)
          - 12. Chloride-slag, containing 8 to 10 per cent. lead, which lead contains 2 per cent. silver. (Added to No. 2.)
          - 13. Rich lead, 4 ctr. (Added to No. 11 to make No. 14.)
        - 10. NH_3. (Escapes.)
        - 11. Rich lead, 26 ctr. (Added to No. 13 to make No. 14.)
        - 14. Rich lead, 30 ctr., containing 2.7 per cent. of silver. (Cupelled.)
    - 4. Desilverized lead, 12½ to 13 tons, containing 0.0002 per cent. (0.058 oz.) silver. (Treated 24 hours with 3 ctr. PbO, SO_3 and 1 ctr. $NaCl$.)
      - 15. Chloride-slag, 3.50 ctr., containing 25 per cent. lead. (Added to No. 18.)
      - 16. Dezincified lead. (Treated 12 hours with 0.8 ctr. unslaked lime.)
        - 17. SOFT LEAD.
        - 18. Antimonial product. (Passed through the blast-furnace, with slag.)
          - 19. Hard lead, containing 2 to 3 per cent. antimony. (Treated with lime.)
            - 21. LEAD. (Second quality.)
            - 22. Antimonial product. (Reduced in blast-furnace.)
              - 23. Hard lead, containing 10 to 14 per cent. antimony. (Refined with 0.5 per cent. NaO, NO_5.)
                - 25. REFINED HARD LEAD.
                - 26. Antimonial oxides. (Added to No. 22.)
              - 24. SLAG.
          - 20. SLAG.

CHAPTER XVIII.

AVOIDABLE WASTES AT AMERICAN SMELTING-WORKS.

In a former paper* on western smelting-works, I have mentioned the great difficulty of obtaining accurate information in regard to the economy of the processes in practice; and to-day, although nearly two years have elapsed since my former paper was written, I have to complain of almost equal looseness in keeping the accounts, and of the same unsystematic management in the majority of these works. I am quite certain that by this time even the most sanguine furnace-managers must have become convinced, from the experience of the last year, that somewhere in their processes there are enormous losses. Rates for the purchase of ores in 1873 were not high, as they were in former years in certain parts of the country; labor was no higher than formerly; the demand for imported lead was good throughout the year, with the only exception of the time of the panic in the fall of 1873; yet there are not more than two or three smelting-works in Utah and Nevada to-day that have paid a reasonable interest on the capital invested. Why, then, not commence at the root of the evil and bring some system into the business? Why not give up the idea, which, I am sorry to say, has so long prevailed with the majority of mining and smelting companies, that smelting is the art of converting, by means of heat, the solid minerals into liquid form, and that if this condition is only complied with, the precious metals will separate from the gangue of their own accord, and that everybody generally, and new patent-process men in particular, can manage metallurgical works; that it is a business which requires no specific training except that which a few weeks or months of personal experience can give to anybody, and especially to the "practical miner, whose experience extends over the whole space of time since '49, and all over the Pacific States and Territories."

Had book accounts been kept at all the western works, as they have been at a very few, it would have long been clear to even our practical men that it is not beneath the dignity of the free-born American citizen to learn from and utilize the experience acquired by centuries of patient study and practice in Europe; that smelting-works must be managed with a view of extracting all the metals in the ores which can be profitably obtained, and that to do this it is necessary to watch closely every stage of the processes with intelligent eyes. Besides the negligence in accounts, the use of the chemical laboratory as a guide in the operations has been shamefully neglected, so that it is quite safe to say that the majority of smelters actually do not know what they are doing.

It is impossible, as I said before, in the absence of the proper accounts, to give detailed and correct data in regard to the losses incurred at the majority of works; but, fortunately for the statistician, most of our western smelting-works labor under the same or very similar circumstances, technically as well as economically; and if we, therefore, find out the losses in one we may reasonably suppose that we have a fair indication of the losses of the others, especially if we have convinced ourselves, from repeated personal inspection, that the works we take as standards are, if anything, better managed than the rest. Indeed, the very fact that at these works accounts are kept and the laboratory is brought into requisition beyond the mere determination of values of ore and bullion, is proof of more intelligent and, therefore, better management.

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* This chapter was prepared by Mr. Eilers as a practical illustration of the conclusions to be drawn from the numerous data given in this and former reports on the subject.—R. W. R.

I have had the good fortune to persuade some friends of mine in charge at smelting-works, the one at Eureka, Nev., the other in Utah, to communicate to me the losses incurred at their works. I am the more thankful to them for this favor as they have, for the benefit of the public, disregarded the danger of divulging company secrets, and because they have conquered their professional pride to the extent of acknowledging extraordinarily large losses, for the sake of the truth; for be it said here plainly that, even in regard to old and well-established works in foreign countries, where it is supposed that no information is ever kept back, the true losses are seldom made known. Allowances in the purchase of ores to smelting-works, rivalry, and professional pride of the metallurgists in charge, prevent such inquiry effectually.

The object of this paper is to direct the attention of those interested to the sources, and especially to the magnitude, of the losses in the silver-lead smelting-works of the West; and if thereby only one-tenth of the wealth now wantonly, and in many cases irreparably lost, is saved to the nation, the labor involved in this discussion will be amply compensated.

The principal losses in western works are occasioned by the escape of the furnace dust and by the neglect to work the matte and speiss formed. In order to arrive at average figures for the money value of these losses throughout the West, I shall here give such figures, in addition to those collected by myself, as I have been able to obtain.

M. P. L. Burthe, a French engineer of mines, who studied the smelting processes of various works in Utah in 1873, gives, in a late publication of his experience, the losses of the Flagstaff, Last Chance, and Wahsatch furnaces as follows:

Losses in percentage of dry assay of ores.

Name of works.	Lead.	Silver.	Gold.
	Per ct.	*Per ct.*	*Per ct.*
Flagstaff	15.03	15.64	12
Last Chance	21.09	12.50	12
Wahsatch	16.93	12.05	......

Mr. Ellsworth Daggett, formerly the manager of the Winnamuck Works, in Bingham Cañon, who saved his matte but not his ore-dust, gives, in a paper published in the Commissioner's report for 1872, the losses at his works as 3.82 units of lead, or (as his ore assayed 34.98 per cent. of lead) 10.9 per cent., and three ounces of silver, or 5.8 per cent., the ore assaying 51.46 ounces.

The following records of two campaigns are from the manager of the only works in Utah which possessed, in 1873, condensation-chambers. The latter were, however, entirely inadequate for the purpose, and the manager acknowledged that he could not save half his dust. At the same works the matte produced in the shaft-furnace smelting was saved for further treatment. The figures, as originally received by me, gave the amounts of raw material and product only; the remaining columns I have added for the sake of comprehensiveness.

Campaign from October 27 to December 4, 1873.

Materials used.	Amount in pounds.	Contents of lead.		Contents of silver.		Contents of copper.		Remarks.
		Pounds.	Per cent.	Ounces.	Ounces per ton.	Pounds.	Per cent.	
Ore	1,618,458	454,889	28.1	27,859	34.4	8,092	0.5	
Iron ore	323,601	....	....	....	....	....	....	Iron ore contains 15 to 22, average 20 per cent. iron.
Coke	323,692	....	....	....	....	....	....	Coke contains 11 per cent. ashes = 35,606 pounds of slag-material.
PRODUCTS.								
Lead bars	280,543	....	....	22,989	163.88	....	....	
Matte	47,980	23,900	49.8	1,320	55.2	7,197	15	
Dust I*	40,000	14,200	35.5	730	36.5	(?)	(?)	
Dust II	36,254	12,000	33.1	504	27.8	(?)	(?)	
Dust I and II	76,254	26,200	34.35	1,234	32.3	(?)	(?)	
Slag. (approximately.)	1,496,978	29,939	2.0	59.9	0.08	....	....	From 2 to 3 per cent. of lead; average assumed, 2 per cent.

* The dust was collected at two different times. The whole was worked over, and yielded 15.000 pounds of lead and 800 ounces silver, while a portion, not given in the statement received, was again saved in the dust-chamber.

Campaign from December 4 to 25, 1873.

Materials used.	Amount in pounds.	Contents of lead.		Contents of silver.		Contents of copper.		Remarks.
		Pounds.	Per cent.	Ounces.	Ounces per ton.	Pounds.	Per cent.	
Ore	640,642	235,849	36.81	9,518	29.71	(?)	....	
Iron ore	164,000	....	....	....	....	....	....	
FUEL.								
Coke	168,030	....	....	....	....	....	....	
Stone-coal	60,000	....	....	....	....	....	....	
Charcoal	6,000	....	....	....	....	....	....	Charcoal, 500 bushels at 12 pounds each.
PRODUCTS.								
Lead bars	161,065	....	....	9,462	117.49	....	....	
Matte	15,000	5,000	33.3	300	40	900	6	
Dust	30,000	10,500	35	450	30	....	....	
Slag	....	....	1 to 3	....	.08	....	....	

If we analyze these tables for the purpose of determining the actual losses, we find in the first one that, in spite of dust-chambers and the saving of matte, there were lost: lead, 124,246 pounds = 27.3 per cent. of the ore-contents; silver, 2,316 ounces = 8.31 per cent. of the ore-contents, of which there are accounted for in the slag: lead, 29,939 pounds; silver, 59.9 ounces; leaving still 94,307 pounds of lead and 2,256 ounces of silver, or 20.7 per cent. lead and 8.1 per cent. silver, which must be supposed to have been lost in uncaught dust principally, though a portion was no doubt in furnace-residues not mentioned in the tables.

If no matte had been saved and no dust caught, as is the case in the great majority of Utah smelting-works, where, furthermore, furnace-residues and *débris*, generally so rich in lead and silver, are also thrown on the dump, the loss in this particular campaign would have been, in lead, 174,346 pounds = 38.3 per cent. of ore-contents; silver, 4,870 ounces = 17.4 per cent. of ore-contents; copper, 8,092 pounds = total ore contents; and of total value of contents = 26.8 per cent.

From the second table we can deduce the following losses and gains: lead lost, 59,284 pounds = 25.1 per cent. of the ore-contents; silver gained, 694 ounces = 7.3 per cent. (nearly) of the ore-contents. Had the matte and dust not been saved, the loss would have been: lead, 74,784 pounds = 31.6 per cent. of ore-contents; silver, 56 ounces = 0.58 per cent. of ore-contents; copper, 900 pounds at least; and, of total value of contents, 15.3 per cent.

The gain in silver recorded in this campaign is no doubt due to a considerable allowance made to the smelting-works in the ore-assays. If the true contents of silver in the ore were known, the balance of the account would certainly stand on the other side of the balance-sheet. As it is, the gain of the works is somewhat over 2 ounces per ton of ore, an amount which is no doubt smaller than is usually gained in the sampling, weighing, and the assays by smelting-works.

The proportion of the quantity of matte to that of argentiferous lead produced in the first campaign is 1:5.8. The money-value of the matte saved, if we assume the same values per pound of lead and per ounce of silver in the two, and a value of $2.50 per unit for the copper, is 8.85 per cent. of that of the argentiferous lead, or 6.64 per cent. of that of the ore.

In the second campaign the proportion of the quantity of matte produced to that of the argentiferous lead is 1:10.7, and the value of the matte saved is 3.78 per cent. of that of the "base bullion," or 3.22 per cent. of that of the ore. The value of the dust saved, which is, according to the statement of the superintendent of the works, less than half of what is actually blown out of the furnaces, represents in the first campaign 4.9 per cent. of the ore-value, and if no dust had been saved, the value thus lost would have been at least 9.8 per cent.

In the second campaign the dust saved represents 4.6 per cent. of the ore-value, and at least 9.2 per cent. would have been lost had no dust-chambers been used.

From the foregoing data we may fairly estimate that in the great majority of Utah smelting-works there is at least lost of the original value of contents in the ore treated: in matte, 5 per cent.; in dust, 9 per cent.; total, 14 per cent., while an additional loss occurs in slag, furnace-residues, careless handling, &c., which may reach 12 per cent. of the ore-contents, and is certainly not less than 5 per cent.

In Eureka, Nev., where far longer campaigns are made than in Utah, nearly the whole loss in smelting has its source in the dust and the speiss formed.

According to data, which I have received from one of the works at that place, and which may be assumed for all of them for the purpose of this paper, as the ores treated are of the same quality and of nearly the same value at all the works, the production of lead is 83 per cent.; of silver, 82.3 per cent.; of gold, 96.4 per cent.; and of the precious metals 86.4 per cent. of the original contents of the ore; the loss of the latter is, in dust, 8.6 per cent.; in speiss, 4.4 per cent.; in slag, &c., 0.6 per cent.; total, 13.6 per cent. Speiss is produced in proportion to lead-bars as 1:2.

At another smelting-works at the same place the production has been found to be: of lead, 81 per cent.; of the precious metals, 85 per cent.; and the loss of the latter is: in dust (nearly) 10 per cent.; in speiss, 5 per cent.; total, 15 per cent.

The losses at Cerro Gordo, in Inyo County, California, of which I have been unable to get even approximate data, I estimate to be less than those at Eureka. I can only judge of this, however, from the fact that a portion of the dust is saved and reworked, and the matte is, in at least two works, thrown back into the ore-smelting without a previous roasting. As there is a lack of sulphur in these ores, part of the copper is driven into the lead at every smelting, and eventually all is incorporated in it, to the great detriment of the purity of the lead.

The foregoing data give us an opportunity of estimating in money-value the avoidable waste of the precious metals and of lead in the smelting-works of Utah and Nevada, by applying them to the production of the respective works.

This production was for 1873:

In Utah:	
From all works, including Tecoma, 9,566 tons:	
Value of gold and silver	$2,135,911
Value of lead, at $80 per ton	765,280
Total	2,901,191
In Nevada:	
From all works, including Railroad district, Truckee, and several small works along the Central Pacific Railroad, 12,811.89 tons:	
Value of gold and silver	$4,038,284
Value of lead, at $80 per ton	1,024,951
Total	5,063,235

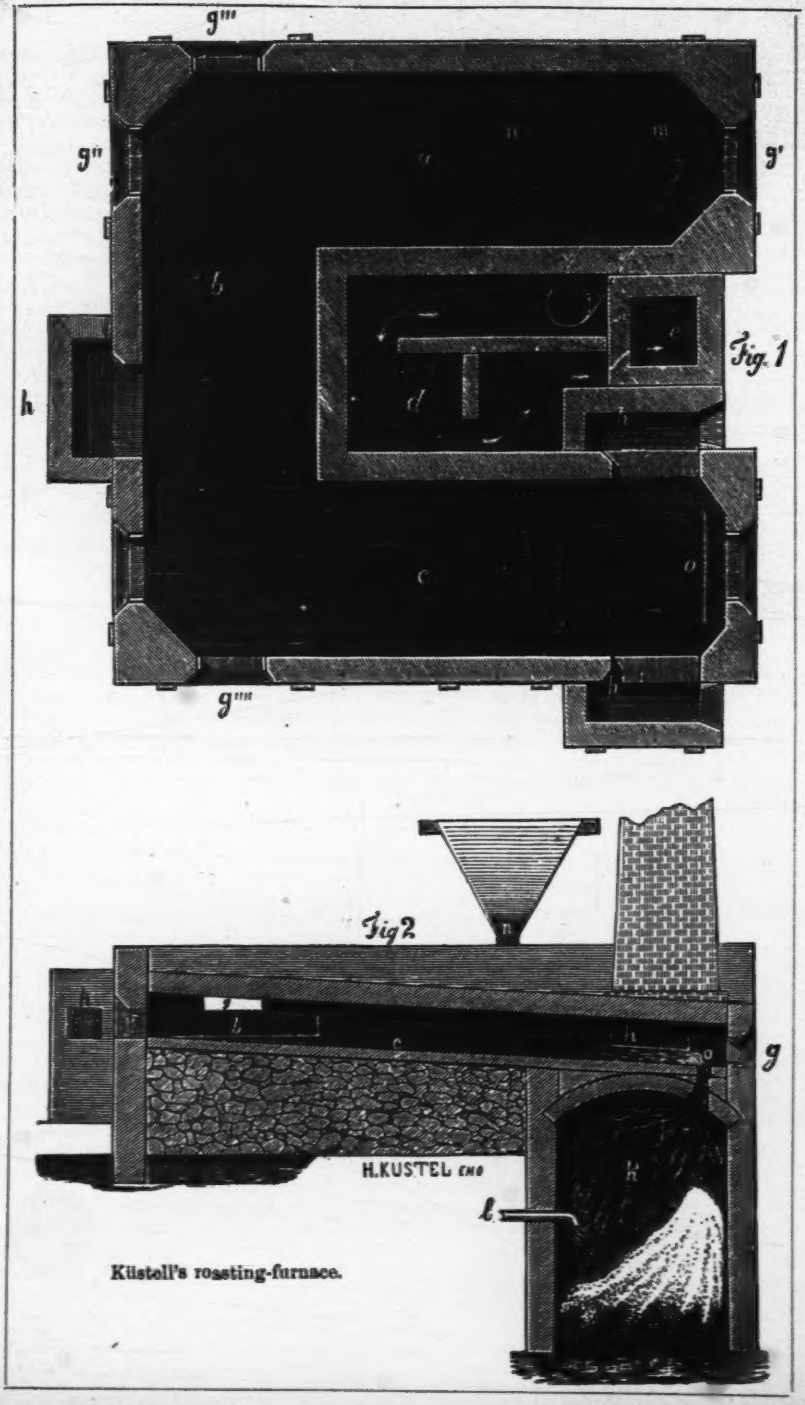
The production of Utah smelting-works, $2,901,191, represents, according to the above data, not over 81 per cent. of the ore-value, and the 14 per cent. lost in the shape of matte and ore-dust would thus, at a low calculation, amount to $501,440, without taking any account of the copper lost also in the matte.

If we assume for Nevada works the most favorable figures given above, those of the first works mentioned, and accept the statement that not more than one per cent. of the loss of lead is lost in the slag, we have the loss in speiss and dust of—

Lead	$197,581
Gold and silver	603,422
Total for Nevada	801,003
Total for Utah	501,440
Total	1,302,443

This is only for the year 1873. It is, indeed, a sad reflection that losses at this rate have been going on for years, for the greater part of which there seems to be now no reparation. The ore-dust is certainly lost forever. The matte may be partly regained at a much higher cost of handling than if it had originally been kept separated from the slag; the speiss is, probably, also lost, because, once solidified, it will cost too much to crush it for roasting and subsequent treatment.

For professional men, it is unnecessary to add anything to the foregoing statement. They will know how to utilize economically the riches now so carelessly wasted. Non-professional owners of smelting-works cannot be too deeply impressed with the importance of expending the



Küstell's roasting-furnace.

small amounts required to build capacious condensation-chambers in connection with their works, and to erect such additional apparatus as may be necessary, in order to utilize the values contained in the matte. At the same time they ought to provide their works with complete chemical laboratories, which are, so far, I am sorry to say, nowhere to be found. It is only by subjecting raw materials, educts and products, to frequent analyses, that smelting processes can be conducted intelligently and economically. In the chapter in this report, on the smelting-works of the Harz, will be found ample information in regard to a system which is peculiarly adapted for our western works. That this system may have to be modified in certain details, according to local circumstances, I need not add. To discern the necessity of such changes is the business of the trained metallurgist, and no other should ever be put in charge of a business in which so much depends upon the proper supervision of operations. The sooner the above suggestions are acted upon, the better will it be for the individual owners, and for the nation. It is high time, even in this rich Union, to put a stop to wanton waste of the precious and other metals, and to add, hereafter, to the wealth of the world, what has, so far, been only a source of useless expenditure.

CHAPTER XIX.

KÜSTEL'S ROASTING-FURNACE.

This apparatus is an improved reverberatory, and although I am not in possession of detailed working results from actual practice with it, the eminence of its inventor, Mr. Guido Küstel, of San Francisco, as a skillful and experienced metallurgist, entitles it to a place in this report. By the courtesy of Mr. Küstel, I am able to present drawings of the furnace, and the following description of it from his own pen:

> Whoever has been engaged in roasting ores will admit that different classes of ore, for instance, gold sulphurets, (iron pyrites,) decomposed silver-ores, silver sulphurets, blendic-ores, &c., cannot be treated exactly in the same way, if the best roasting results are to be obtained. In this respect the old reverberatory was the proper furnace. The roaster had it in his power to modify the heat, the time of roasting, the amount of salt, lime, or sulphate of iron; the proper time of adding these ingredients, &c., till oxidation or expulsion of volatile base metals and chlorination of the silver was accomplished. But the expense was too high and the time of roasting too long. The introduction of the long reverberatory roasting-furnace diminished the expense and shortened the time of roasting, but the moving of ore from one end to the other through side doors was very tedious, and the roasting-time still too long, and the amount of labor required large.
>
> All the disadvantages above mentioned are obviated by Küstel's improved furnace, of which Figs. 1 and 2 give a clear illustration; they are drawn to a scale of 6 feet to 1 inch. Fig. 1 is the horizontal and Fig. 2 the vertical section. There are in this furnace two very important improvements. The first consists in breaking the straight line of the long furnace. The working-doors *g g* are placed so that no lateral work is performed; only drawing and pushing on an inclined hearth is required. The ore is introduced through the hopper *u*, on the upper hearth *a*, spread equally, and after an hour's time drawn at g'' and pushed from g' upon the second inclined hearth *b*, and from this upon the third, *c*, in the same way. No stirring is required unless very difficult ore is under treatment. The moving of the ore from one end of the furnace to the other is generally sufficient. The necessary heat is kept up by two or three fire-places, *h h*. The gases pass through the flue *m* above the roof into the dust-chamber *d*, and escape through the chimney *e*. The arrangement of having the working-doors at the end of the long sides enables the roaster to do a great deal more work than if tired out in the old way of moving the ore toward the fire-bridge.
>
> The other improvement refers to the chloridizing chamber K, Fig. 2. The purpose of

this chamber is to shorten the time of roasting. It has been ascertained that the ore at rest in a red-hot condition continues to be chloridized when drawn out of the furnace. The ore falls through the opening, *o*, into the chamber, and remains there red-hot for two or four hours, as may be required. Chlorine and volatile chloride metals, that are evolved, pass into the furnace and continue to chloridize the ore all along the furnace. In case there is no sulphur in the ore, sulphurous acid gas can be introduced through the pipe *l*, simply by burning sulphur. The sulphurous gas is transformed into sulphuric acid and liberates the chlorine from the salt.

The inventor states that a furnace of this kind, by the aid of the chamber K, can put through from 15 to 20 tons of ore in twenty-four hours, employing two shifts of three men each, consuming less than one-fifth of a cord of wood per ton of ore. The roasting being perfectly under control, the highest percentage of chloride of silver is obtained.

Without interfering in the least with the advantages alluded to, these furnaces can be worked just as well by an approved mechanical arrangement, so that a continuous feeding direct from the battery is effected. Local circumstances will decide whether hand-work or machinery is preferred. The discharge of the ore from the chamber can be made at intervals or continuously by giving to the bottom a funnel shape and applying an endless-chain arrangement. A few small holes through the brick-work funnel may serve for the use of an iron rod in case choking occurs. The patent refers not only to the shape as represented by Figs. 1 and 2, but to any breaking of the straight line of a long furnace by which the lateral work is avoided.

CHAPTER XX.

BRÜCKNER'S CYLINDERS.

The Brückner cylinder, or revolving furnace, has been repeatedly described and alluded to in my reports, but I have never until now been able to present drawings illustrating its construction and use. Deeming it a highly successful apparatus, I give the accompanying illustrations of it, and quote the following paper, by Mr. C. M. Locke, civil engineer, of Cincinnati. I regret that exact and detailed working results are not yet at my disposal.

Brückner's revolving cylinders for roasting ores, &c., are now used at a number of the mills in Colorado and New Mexico, for the purpose of roasting and chloridizing silver-ores, with highly satisfactory results, even from those cylinders of small size, erected before the many improvements of recent date.

As examples of the larger improved cylinders, reference can be made to those erected at the Tennessee Reduction-Works, Silver City, Grant County, New Mexico, and those which were built, in 1871, at the celebrated Caribou Silver Mill and Mines, Colorado, a mining enterprise which has proved so satisfactory as to have been lately sold to a Holland company for an enormous amount.

Description of their construction.—These cylinders, as now constructed by Messrs. Lane & Bodley, of Cincinnati, Ohio, are shown in the accompanying cuts, of which Fig. 1 is an elevation in perspective, Fig. 2 a longitudinal, and Fig. 3 a transverse section.

The exterior of the cylinder is a shell of boiler-iron, 12 feet long by 5 feet 6 inches in diameter. The ends are partially closed with similar material, leaving in the center a circular opening about 2 feet in diameter, bounded by a flange projecting several inches. Upon one side is placed an opening closed by a hinged door. Upon the outside of the cylinder are bolted three bands, as shown in Fig. 1, in which the section of the first is square, and that of the third semicircular; the second, or middle band, is a strong spur gear. Passing through the cylinder are six pipes parallel to one another, in a plane at an angle of 15° to the axis of the cylinder; these pipes also lie in this plane at an angle of from 30° to 35° to the longitudinal axis of the plane, as shown in Fig. 2, where the internal arrangement of the cylinder is seen, a perforated diaphragm being formed through part of the cylinder by means of perforated plates placed between the above described pipes, the plates being held in place by longitudinal grooves upon these pipes.

The entire cylinder is lined with brick, (common building-brick have been found to answer the purpose very well,) the brick being placed in the following manner: The

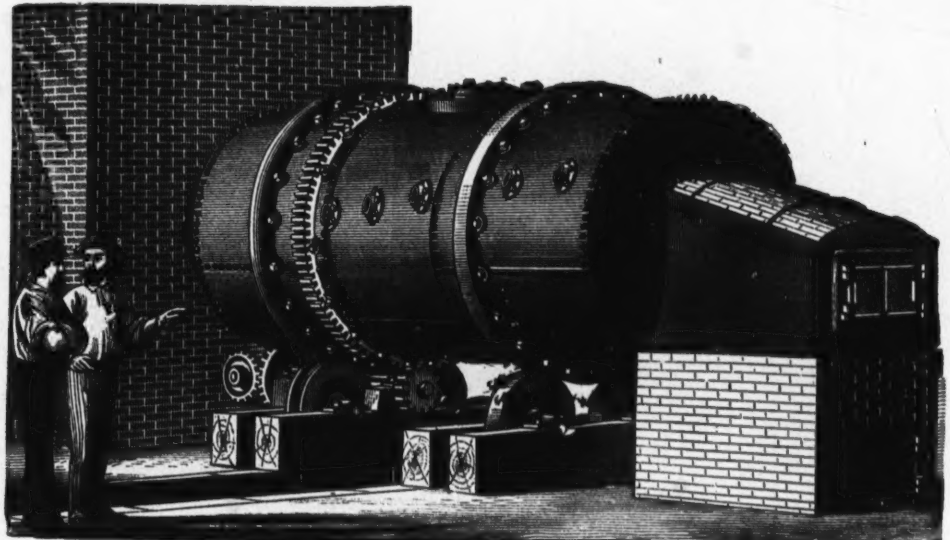


Fig. 1.

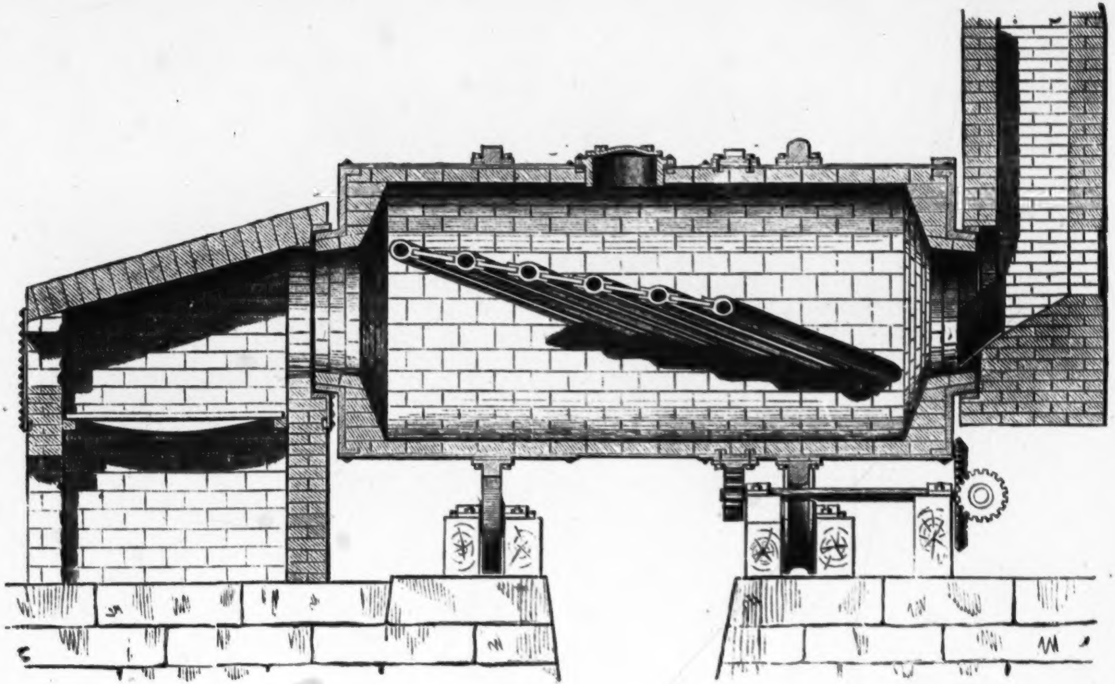


Fig. 2.

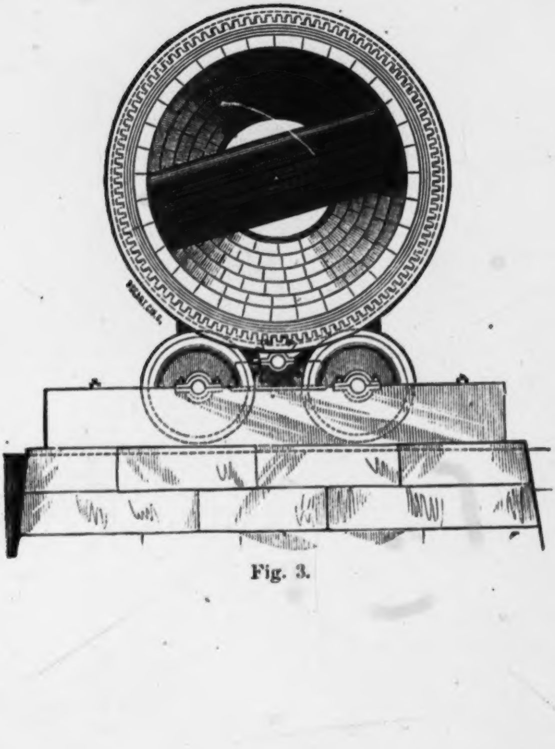


Fig. 3.

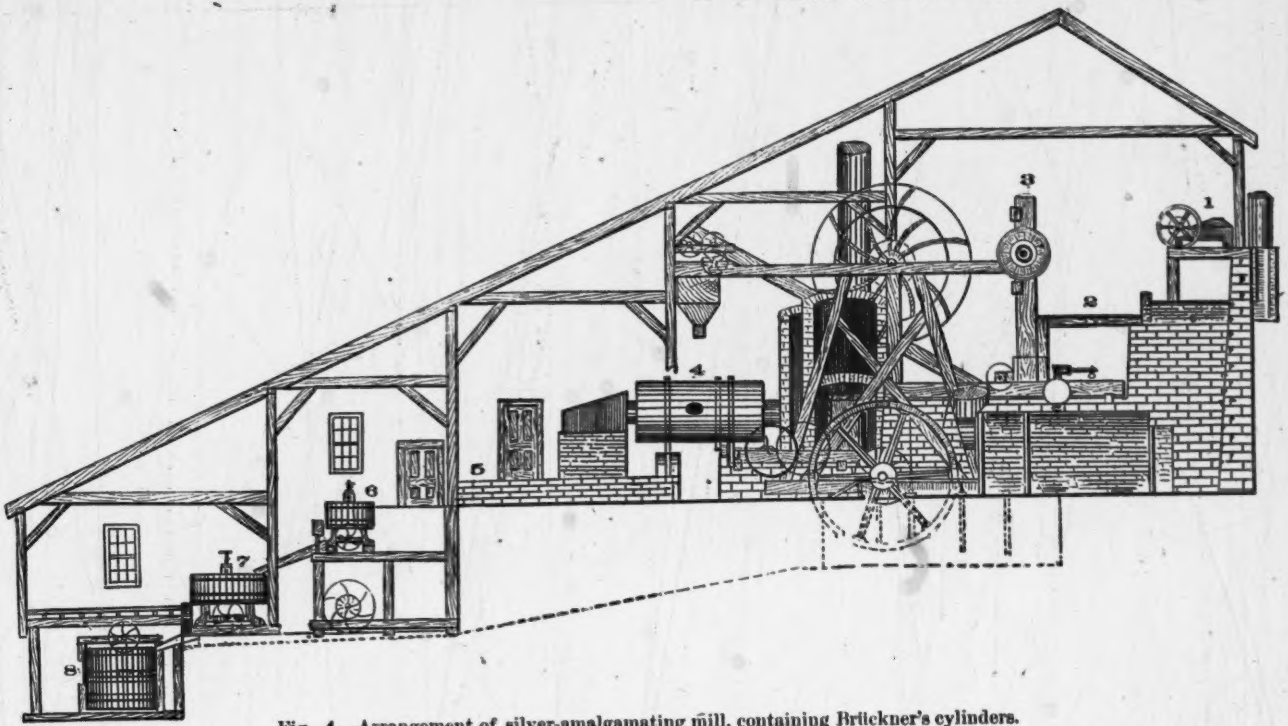


Fig. 4.—Arrangement of silver-amalgamating mill, containing Brückner's cylinders.

1. Rock-breaker; 2. Charging-floor; 3. Stamp-battery; 4. Cylinder; 5. Cooling-floor; 6. Amalgamating-pan: 7. Settler; 8. Tank.

entire side of the cylinder is covered with one layer, laid flatwise, thus forming a lining about 2½ inches thick; there is an additional layer extending from each end of the cylinder about 15 inches to the center of where the nearest pipe passes out; then additional concentric layers are added thereon, until the circle is contracted down to the size of the opening in the end, which is also lined, and each layer falls short of the preceding one about 2 inches, thus giving the end linings a conical form, the entire lining being laid in a mortar of one part fire-clay, two parts pulverized old fire-brick, and water, all thoroughly mixed and beaten. The cylinder is supported upon four large friction rollers, two of which are grooved upon their periphery, to loosely fit the semicircular band, thus holding the cylinder longitudinally in place. The other two friction rollers are made without a groove, and bear upon the square band, thus accommodating themselves to the expansion and contraction of the cylinder, or any irregularities of form, all of which can be seen in Fig. 1. Rotary motion is given to the cylinder by means of a pinion placed under the cylinder and gearing into the spur gear band. Upon the other end of the pinion-shaft are placed two bevel wheels, into which gear two match wheels, which latter are loose upon the driving-shaft, standing at right angles to the pinion-shaft, and either of which wheels can be attached to the driving-shaft, thus communicating the speed of revolution of one or the other of the bevel gear as may be desired. Inasmuch as by wear or settling, the axis of the cylinder may possibly be thrown out of the proper line, the following means of adjustment are provided, but not shown in any of the figures, viz: Each journal-box of the friction rollers is held in position by adjusting-screws, by which it can be moved horizontally to or from the center line of the machine, thus giving entire control of the lateral and perpendicular adjustment of the cylinder which they support.

The circular flange of one end of the cylinder loosely projects into a fire-box, best seen in section to the left of Fig. 2. The other end projects into an opening communicating with dust-chambers and a chimney. There is placed in the bottom of the flue a shoe projecting into the cylinder, which catches such dust as may fall back, and returns it into the cylinder in lieu of allowing it to escape through the crevice between the cylinder-flange and opening into the flue. A door is placed in the flue opposite the opening, through which the interior of the cylinder and its contents can be readily examined at any time.

Method of operating the cylinder with refractory silver-ores.—A fire having been kindled in the fire-box, the cylinder is allowed to slowly revolve until heated to a dull red, and is then brought to rest with the door on top. In this position about 4,000 pounds of pulverized ore and 200 to 400 pounds of salt are introduced; the door is closed and securely fastened, and the cylinders are made to revolve at the slower speed of from one-half to one turn per minute. The fire is so regulated that after an hour's time the sulphur contained in the ore commences to burn, the ore in the cylinder being retained at a dull red for some time. (In those ores containing a large amount of sulphur, little or no additional fuel is required for desulphurization.) During the whole of this and the subsequent operation the inclined perforated diaphragm causes the heated ore to traverse alternately backward and forward the entire length of the cylinder, also sifting it through the flame, thus insuring a uniform heating, mixing, and exposure to chemical action.

The diaphragm, in the mean time, is protected from destructive action of heat by the cooling effect of the external air circulating through the pipes, and from corrosion by the formation of a basic scale, or coating, resulting from reaction of the iron pulp, &c.

The desulphurization being completed, the heat is gradually augmented to a full red. The pulp soon assumes a spongy appearance, technically known as "woolly," in consequence of the double decomposition of the sulphates (formed during desulphurizing) and salt, (chloride of sodium,) liberating chlorine gas, &c. After an hour's time, or as soon as a sample taken from the cylinder evolves the odor of chlorine uncontaminated with that of sulphurous acid, which indicates that the chlorination is complete, the door in the cylinder is opened, and the cylinder revolved by the more rapid moving gear, and the chloridized ore is quickly discharged, being received into a car, shute, or other conveyor, according to the construction of the mill.

The door in the back of the flue furnishes a ready means for sampling and examining the condition of the ore in its progressive stages, and in some cases the salt is not added to the ore until subsequent to desulphurizing, in which case this flue door is conveniently used.

Other uses of the cylinder.—The cylinder has been found to give excellent results in roasting the compound auriferous pyriti ores to be treated by the Plattner process, in which case a small quantity of charcoal is subsequently introduced to the charge, so as to facilitate the decomposition of the resultant sulphate of copper. This form of cylinder is undoubtedly well calculated for the manufacture of soda from cryolite, roasting cement, plaster of Paris, ores of zinc, lead, copper, &c. In a word, it is admirably adapted to most of the roasting and reverberating furnace operations.

Cost, weight, and capacity of the Brückner cylinders.—The cost of a cylinder, including its supporting and rotating machinery, iron-work for fire-box, bolts for foundation, and all royalties on patents, is about $2,100. The total weight of the foregoing parts is 16,000 pounds; the placing of the foundation and erection of brick-work for fire-box, cylinder linings, and dust-chambers, will vary greatly according to local circumstances. The capacity of a cylinder in twenty-four hours is, as reported by Mr. Chas. E. Sherman and indorsed by B. O. Cutter, from 8 to 10 tons, (in very refractory ores the daily average would be less, J. M. L.,) the chloridizing being up to 96 per cent. These statements are based upon their experience at the Caribou Mill, Colorado. H. D. Breed, esq., proprietor of the same mill, gives the actual total cost of roasting and chloridizing at $5.50 per ton. This low cost renders it feasible to work with profit very low-grade ores. After examination of what has been stated in regard to the cylinder, by Professor Raymond, United States Commissioner (1); Clarence King, in charge of the geological survey of the fortieth parallel (2); Küstel (3); Burlingame, superintendent of the Tennessee Mill, Silver City, N. M. (4); A. Wolters, at present superintendent United States Mint, Boise City, Idaho (4); H. Stoelting, at present territorial assayer of Colorado (4); Professor Danby (5); Chas. E. Sherman (6); B. O. Cutter, (6); and A. D. Breed, all of the Caribou Mill, Colorado; and an examination of the improved cylinder, as now manufactured, I am convinced that it possesses the following advantages:

1st. A thorough and uniform accomplishment of its work.

2d. A complete control of its action irrespective of the character of the material acted upon.

3d. A high percentage of chlorination, and, therefore, of yield, with ores of the precious metals.

4th. Low cost.

5th. Little wear and tear and ease of repairing.

6th. Skilled labor is not a requisite in its management.

7th. The size of the apparatus permits it to be readily adapted to the size of a mill by simple reduplication.

CHAPTER XXI.

A METALLURGICAL LABORATORY.

The Massachusetts Institute of Technology, at Boston, possesses a novel feature in its practical laboratories for the concentration, amalgamation, and smelting, of gold and silver ores. Precisely how important in the training of students such adjuncts will be, remains to be proved by experience. Of course there is much which can only be learned by actual practice on a larger scale. But there is a great deal which can be taught better in such laboratories than from books alone; and the question is merely one of relative expense and profit in teaching, whether such laboratories should be maintained. Meanwhile I have thought it worth while to call attention to this experiment as one which may prove fruitful of good results. The mining (or, more correctly, the crushing, amalgamating, and concentrating) laboratory and the metallurgical (or smelting and assaying) laboratory are shown in the accompanying plates. In April, 1873, Prof. Robert H. Richards, of the Massachusetts Institute of Technology, read a paper on the subject before the American Institute of Mining Engineers, from which the following account is taken:

Of the several professions—the chemist, the civil engineer, the mining engineer, the mechanical engineer—the courses of instruction, as arranged at the scientific schools, differ considerably as to the amount of practical information which the student is able to gain. The analytical chemist has facility for a very thorough review of the pro-

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(1). Report 1871, pages 276 and 748, see appendix.

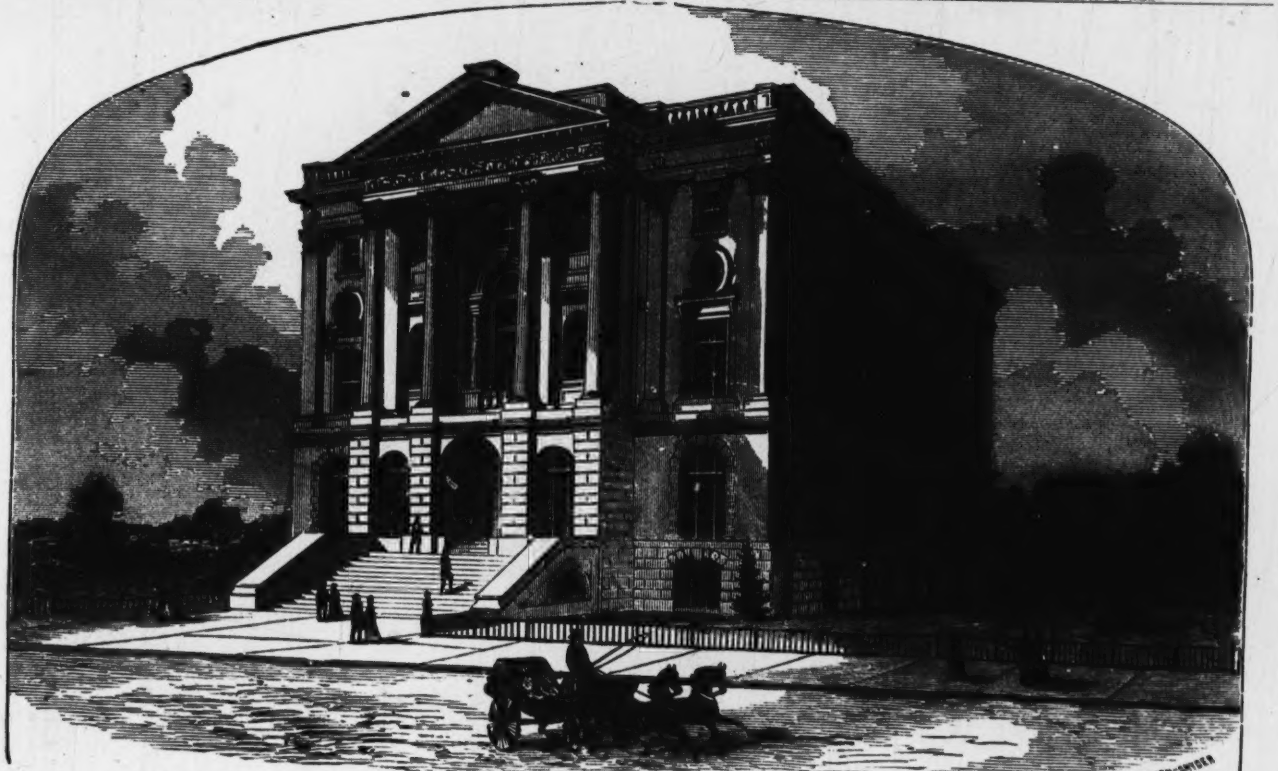
(2). Report geological exploration of fortieth parallel, vol. iii, page 610.

(3). Letter to Robert Peats, 1870.

(4). Report on Brückner's cylinders.

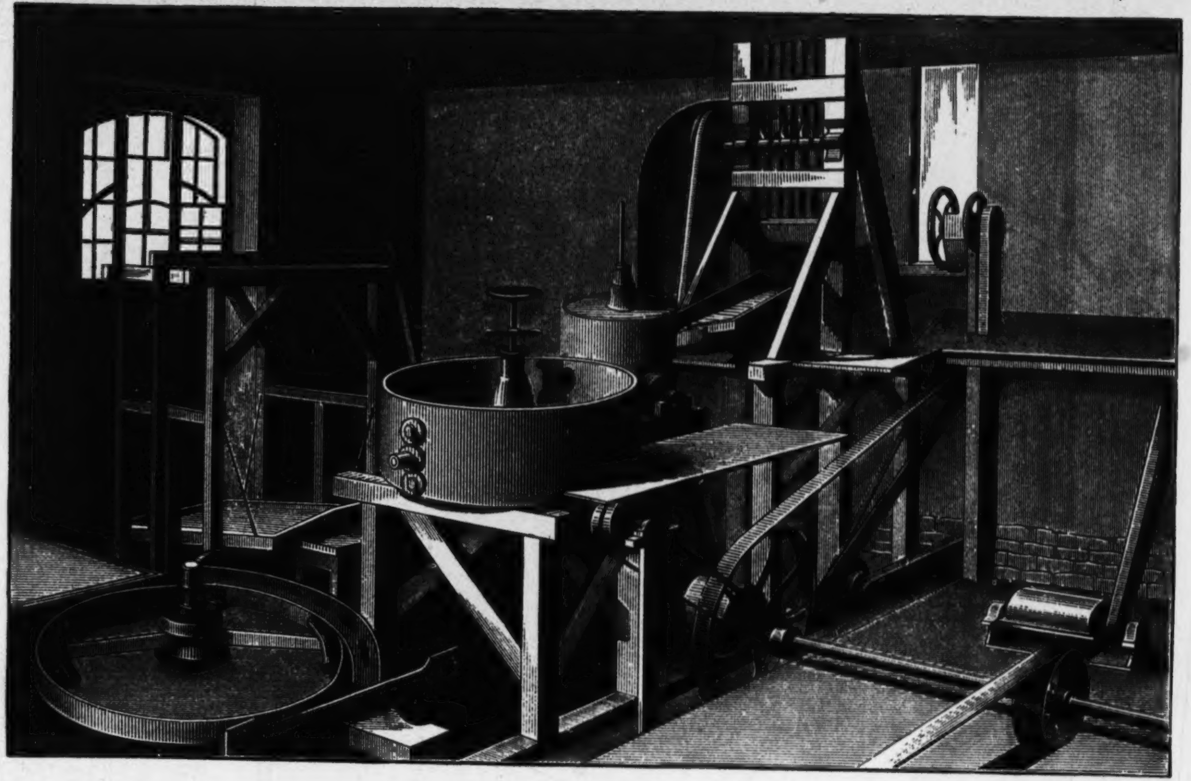
(5). The Caribou Silver Mine and Mill, Boulder County, Colorado, United States, with reports, maps, &c., London. Printers, G. M. M. Taylor & Co., 169 High Holborn, C. W.

(6). Letter by Chas. E. Sherman to B. O. Cutter, June 21, 1871.



The Massachusetts Institute of Technology.

Fig. 1.—Mining laboratory.



cesses which he will be called upon to perform. The student in civil engineering by his field-practice learns the use of his tools and the art of taking field-notes. The mechanical-engineering student is in the vicinity of machine-shops, which he can visit and at which he can work. The student in mining engineering has no such advantages. The mines are at a distance, and the railroad fare to get to them is oftentimes an insuperable difficulty.

The aim of these laboratories is essentially to give to the student in mining and metallurgy a chance to study on a small scale the practical parts of his profession. We cannot, in a small laboratory, build a mine to timber, to work, and to survey. We cannot make artificial quicksands and other impediments to mining. In short, we cannot study exploration; but we can study the mechanical preparation and the subsequent smelting of ores. Before presenting the plan of these laboratories, it may be interesting to indicate the progress of the idea from its beginning.

During the summer of 1870 President Runkle visited the mines of Colorado, and while there conceived the idea of making an expedition with the mining-students to some of the western mining-regions. He talked over the scheme with many railroad and mining-men, and everywhere received encouragement. In the summer of 1871 the institute party visited the mines of Colorado, and spent six weeks in taking notes of them. President Runkle here conceived the idea of building up a mining and metallurgical laboratory; and by the aid of Booth & Co., of San Francisco, a stamp-mill was obtained, with the Washoe silver-working apparatus. During the year 1872 the metallurgical laboratory was brought to its present state of advancement by Professor Ordway.

The two laboratories are intended to give students an opportunity to work on a small scale, with all the mining and smelting laboratory which can be used to advantage in a laboratory; and this apparatus has been chosen with the view to illustrate, as far as possible, the principles of all machines used in mining.

The mining laboratory now contains a 15 horse-power engine, a Blake crusher, a stamp-mill; a Washoe pan, settler, and concentrator; a Rittinger automatic shaking-table, a little hand-jigger, a rotary pulverizer, and a fan-blower. The metallurgical laboratory contains a blast-furnace, a roasting and smelting reverberatory furnace, a cupelling-furnace, assay-furnaces, and a forge. The laboratory is equipped for easy blast-furnace experiments, such as the smelting of copper and lead ores, for roasting-operations on gold, silver, lead, copper, and antimony ores, and for the Freiberg process for silver.

A student receives an ore for examination, and in the presence of his instructor selects specimens containing all its characteristic minerals, which he determines, and then selects the method of treatment. Specimens are saved; the ore is crushed and sampled; assays are made to determine its value. The ore undergoes the treatment which was chosen. Actual results are compared with the assay-value of the ore, and, wherever practicable, the amount of fuel, power, labor, and water consumed is noted.

But few experiments have as yet been tried, since the laboratories are scarcely yet completed. A gold-ore from Acworth, Ga., yielded the following results when treated by battery amalgamation:

Ore taken	176	pounds.
Gold on plate	3.07	grains.
Gold panned from battery	13.4	"
Rate of gold in the ore	$7.76	per ton.
Rate of gold in the tailings	1.57	"
Percentage saved	83	per cent.

Apparatus for iron-working is not yet represented in the laboratories, partly for lack of space and partly because we have not yet decided what furnaces could be most usefully employed in a laboratory. A pair of crushing-rolls is now in course of manufacture.

The mining-schools of Prussia are owned and controlled by the government, as is the case also with most of the mines and metallurgical establishments. In consequence, students have great facilities afforded them for acquiring practical information. In this country no such bond of union exists between the mines and the schools. The schools must here depend on the generosity and sympathy of the public, and to obtain such help they must in some way reciprocate it.

It is fully expected that, by making students do systematic and careful work, results will be obtained which will be of such value to the donors of the ores that they will feel more than repaid for sending them. If this expectation fails, the alternative always remains that ores can be bought and shipped by the school.

The mutual interchange of ideas between the instructors of the institute and the miners which will grow out of such work is regarded as no mean part of the value of this laboratory to the school and to the public.

With regard to working ores for outside interest only, results being returned promptly and a fee received in compensation for work done, I can only say that we have not force enough this school-year to make any promises whatever. I expect to be able to do prompt work in future years.

With reference to the students' work, the suggestion has been made that we should hold a tournament, as it were, for a month, keeping all mining-students engaged at work in their regular shifts; that we should use all the apparatus during the month; have our regular break-downs, stoppages, and patchings up, and settle up accounts at the end of the month, making such assays and analyses as are needed.

At the meeting of the American Institute of Mining Engineers at which the foregoing paper was read the following remarks were made by Prof. W. P. Blake:

I have listened with great pleasure to the reading of this paper. I saw a part of the machinery described when it was set up in the Institute of Technology, and it gave me great pleasure, because I recognized in it a step in the right direction for the instruction of young men and scientific students who desire to apply directly the information they obtain in the laboratory, and to ascertain where they need the most light, and become familiar with those points in practical work which they require. Experience has shown this to be the case upon the western coast, where, after a long and expensive trial of the laboratories of the chemist, the mill-men—the men who were accustomed to do things by main strength—became satisfied that they needed some help from outside, and finding that they could not get it always satisfactory from the assayers and chemists, who did not know what they wanted, and did not care as long as they got their fee for the assays and analyses, they went to work and put up in San Francisco assay-laboratories upon a large scale. It grew first out of a demand, a commercial demand, to ascertain the value, in silver or in copper, of ores shipped to San Francisco. Large quantities of ore were sent by miners from down the coast—from Lower California and Mexico to San Francisco—to be assayed. The parties to whom these ores were sent wanted to know what they were worth. The parties to whom they proposed to sell them would not take the ores upon the ordinary assay of a fragment selected out of the mouth of the sack—would only take them after first getting the ores crushed and sampled in a proper manner to make the assays. The miners found out how this was done, and they went to work and put up establishments of their own where loads of ore weighing perhaps a ton or even less—half a ton or 500 pounds—could be crushed up into small fragments, shoveled together over and over, and then, when they got an honest admixture, they could send the sample to an assayer. After this experience it was very natural that they should desire to know how such ores could be worked; and that led them to try them in the various pans and machines for grinding that have been manufactured. Inasmuch as the samples of ore were not large in quantity, they commenced making small trial-pans—little working models sometimes would answer the purpose—into which they could put 10, 20, or 50 pounds of ore, and work a batch of it. The results were very satisfactory. They gave great satisfaction, not only to the miners who had ores to sell, but to the mill-men and to the manufacturers of machinery, because the parties who were engaged in manufacturing machinery for the miners in the interior could, right in their own establishments, see the many difficulties which the mill-men had to encounter. They became aware of all the conditions connected with the erection and running of their mills and were enabled to provide for them. It has led to a succession of improvements, to the rejection of a great many worthless and useless machines, designed by parties who were not familiar at all with the working of ores, but who had patents on peculiar shaped or formed machines for crushing or grinding, and desired to sell those machines in the markets. Most of these worthless machines have been eliminated from the practice on the Pacific coast; and now I think I may say, without danger, that we make a better stamp-mill in the United States than is made in any part of the world, and we make better machinery for grinding and amalgamation, in pans, at any rate, than has ever been made before. It is very gratifying to any one who has seen the progress of improvement on the western coast, and knows how much has been done there by the experimental works of the mill-men and the miners, to see here in Boston an establishment complete in all its parts and capable of not only educating persons who are so fortunate as to receive instruction here, but also to do a great deal of good, probably, in making us aware of the value of the ores of this region, or any ores that come to this market, and of introducing a better knowledge of mining engineering to the manufacturers of this coast.

Being on that occasion in the chair, as president of the Institute, I expressed substantially the following views on this subject, and quote them here, since I see no reason to change either the opinion or the form:

Besides the function of instruction of students which requires that such apparatus should be of the received form, there is an important function which I think these

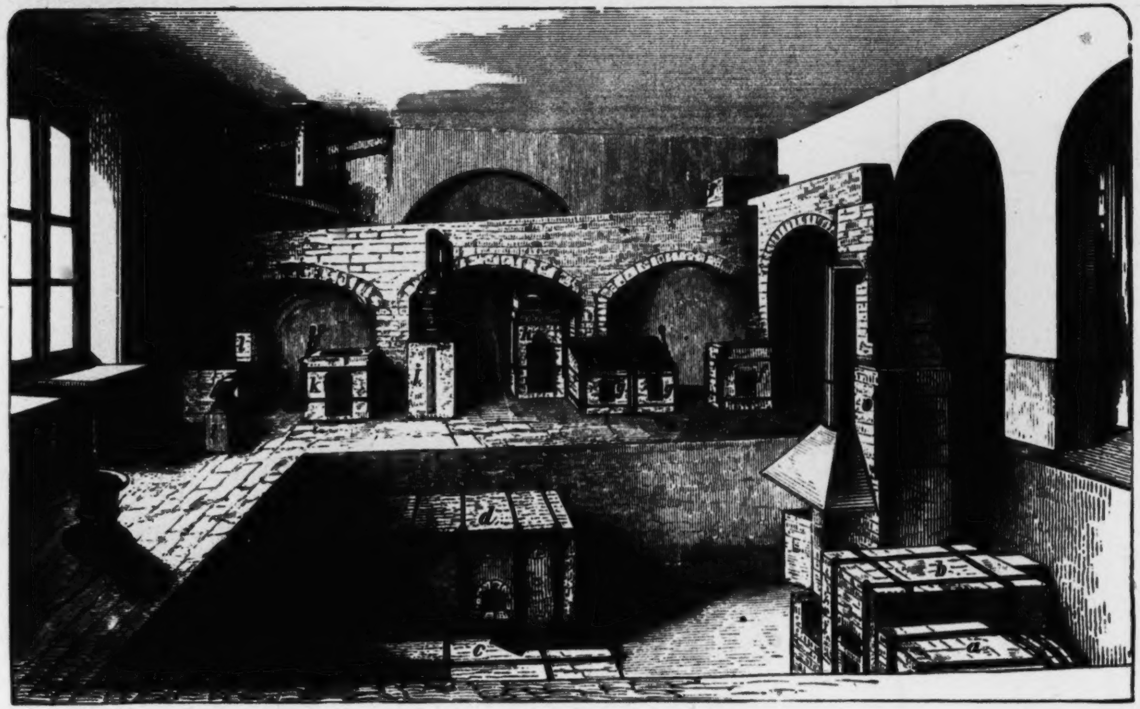


Fig. 2.—Metallurgical laboratory.

practical laboratories will one day fulfill, and that is the carrying out of such experiments as will further improve the processes now in vogue. It is one thing to instruct our young men so that they can go West and handle the machinery now in use there; it is another thing, and an equally important one, to have machinery at our disposal somewhere where it can be run in a truly experimental manner, where truly scientific experiments can be made—by which I mean experiments so shielded from possible complexities and mistakes that the results shall be traceable to the proper causes. I may instance an investigation upon which I entered some years ago, in relation to the efficiency of stamps, calculated with regard to their speed, weight, and drop. Those three elements must have some definite relation to the efficiency of the stamp in the quantity it will crush. It does make some difference whether we drop a heavy stamp a certain distance or a light stamp, weighing half as much, twice as far. I have been for some time a partisan of lighter stamps and more rapid blows than have been the fashion in many parts of the country, and in investigating that question and developing results, although I was able to eliminate from the problem such disturbing elements as depended upon the generation and transmission of power, I was not able to eliminate or perfectly estimate the influence of the facility and area of discharge, which has a decided effect on the quantity crushed, nor, on the other hand, the character of the rock, since in comparing different stamp-mills in different localities you have always to bear in mind that you are comparing them by different standards. Some quartz may crush and does crush easier than others. We must throw out abnormal results on either hand. I have known 72 tons to be run in twenty-four hours through a 10-stamp mill. The average would be something like 12½ to 15, and anything that varies far from that average in either direction might be fairly attributed to some abnormal quality in the rock. To make complete experiments of this kind you want to have all the conditions maintained except one. If you wish to test discharge, you want to use the same battery and the same quartz, and vary nothing but the discharge; if you wish to test the speed and the weight of the stamp, you must vary nothing but the speed or the weight. That is impossible when you come to collect the results of experiments in ordinary practice. You cannot ask the mill-man to vary the weight or speed of his stamps, or to keep taking different kinds of rock, and stop his running at short intervals and clean up with spasmodic frequency, just to suit your desires. Hence, it is almost impossible to get absolute results. I trust the creation of such laboratories as have been described to us in the paper just read will open the door to something like careful work of this character. A specimen of what I mean is furnished by the experimental investigation of the Washoe amalgamation, which was made under the charge of Professor Brush, Mr. Hague, and Mr. Daggett, on the ores of the Comstock lode, at the laboratory of the Sheffield Scientific School at New Haven. The results are published in the third volume of Clarence King's report. Another specimen of what I mean I have been fortunate enough to secure myself, through the assistance of Mr. G. F. Deetken, of Grass Valley, Cal., who has made a very thorough analysis at every stage of the California stamp-mill process.

I think it is a question worthy the consideration of the faculty of this school whether some of the peculiar amalgamating-machinery employed in California might not with advantage be substituted for the simple amalgamation in battery and on copper plates, which is recognized in practice now to be a wasteful method.

PART III.

MISCELLANEOUS.

CHAPTER XXII.

SINKING SHAFTS WITH THE DIAMOND DRILL.

The new method of sinking shafts by means of the diamond drill, to which allusion was made in my last report, has been thoroughly described by Mr. Eckley B. Coxe in a paper read before the American Institute of Mining Engineers, which has attracted much attention at home and abroad, and which, with the permission of the author, I transfer in full to this report. What follows is in Mr. Coxe's own language:

I desire to call the attention of the Institute to two deep vertical shafts, which are now being sunk in Schuylkill County, Pennsylvania, about one and a half miles north of Pottsville. These shafts are of interest to the mining engineer, not only on account of the novelty of the method of sinking adopted, which promises to produce a revolution in that branch of mining engineering, but also as examples of the manner in which such work should be undertaken.

GEOLOGICAL SKETCH OF THE TERRITORY TO BE WORKED BY THE SHAFTS AND REASON FOR SINKING THEM.

The Mammoth or E vein of the anthracite-coal measures in that part of the Schuylkill region near and north of the town of Pottsville lies at a great depth below the surface and has, in consequence, never been worked in that locality.

The Mammoth vein itself is about 23 feet thick, but, as is shown in the following sections, it is overlaid by the Seven-foot vein, which is separated from it by from 4 to 30 feet of rock and slate, so that the two together form a vein of about 30 feet in thickness.

Beechwood Colliery:

Seven-foot vein…	8′ 0″ coal,			
	0′ 3″ slate,	Seven-foot vein:		
	6′ 8″ coal,	Coal…	17′ 9″	17′ 9″
	0′ 6″ slate,	Refuse…	0′ 9″	
	2′ 4″ coal,			
	10′ 0″ slate…	Partition slate.		
Mammoth vein…	6′ 0″ coal,			
	0′ 7″ slate,			
	7′ 6″ coal,	Slate…	1′ 4″	
	2′ 4″ coal,	Coal…	23′ 4″	
	0′ 9″ slate,			
	2′ 6″ coal,	Total…	24′ 8″	
	5′ 0″ rough coal.			

RECAPITULATION.

Seven-foot vein…	17′ 0″ coal,	0′ 9″ refuse.
Mammoth vein…	23′ 4″ coal,	1′ 4″ refuse.
Total coal…	40′ 4″	2′ 1″.
Total refuse…	2′ 1″	
	42′ 5″	

At Pine Forest Shaft Colliery:

Seven-foot vein…	6′ 0″ coal.
Slate…	15′ 0″ to 20′ 0″
Mammoth vein…	20′ 0″ coal.

North of Deep Shafts the slate separating the Seven-foot and Mammoth veins varies from 10 to 30 feet in thickness.

At Hickory Shaft Colliery:

Seven-foot vein averages…	6′ 0″ to 8′ 0″ coal
Slate…	10′ 0″ to 10′ 0″
Mammoth…	20′ 0″ to 24′ 0″ coal.

Section of Seven-foot (called No. 2 vein) and Mammoth veins, near Shenandoah.

Shenandoah City Colliery:

No. 2, or Seven-foot vein	Top slate and rock:		
	Coal	4' 0"	
	Slate	0' 2"	
	Coal	3' 0"	
	Slate	1' 0"	Dip 20° S.
	Coal	2' 4"	
	Slate	1' 0"	
	Coal	2' 0"	
		13' 6"	
	Bottom slate.		

Mammoth vein	Slate between No. 2 and Mammoth vein, sometimes rock:	
	0' 9"	coal.
	1' 0"	sulphur-balls.
	3' 6"	good, bright coal.
	3' 8"	good coal, containing a small streak of bone.
	0' 5"	charcoal bench, soft, dull, sandy fracture.
	0' 3"	coal.
	0' 1"	slate.
	3' 6"	good, bright coal.
	6' 0"	good, bright coal, 5-foot bench.
	0' 8"	slate.
	3' 0"	good, hard, bright coal, 3-foot bench.
	0' 8"	bone.
	7' 4"	very fine coal, 7-foot bench.
	1' 0"	coal, bone and sulphur, sulphur bench.
	31' 10"	
	Bottom slate.	

Plank Ridge Colliery:

Mammoth vein	1' 0"	coal,	Not worked.
	0' 5"	sulphur balls,	
	2' 0"	good coal, a little rough.	
	3' 5"	very good coal.	
	2' 2"	good coal, a little rough.	
	0' 5"	bone and slate.	
	1' 4"	good, bright coal.	
	1' 4"	charcoal bench.	
	5' 6"	good coal, cubical fracture, 5-foot bench.	
	0' 7"	bone and slate.	
	3' 0"	very good coal, 3-foot bench.	
	0' 7"	bone.	
	7' 5"	very good coal, cubical fracture, 7-foot bench.	
	29' 2"		
	Bottom slate.		

	4' 8"	very good coal,	No. 2 vein.
	0' 6"	bone,	
	2' 8"	good coal,	
	5' 0"	good coal,	
Mammoth vein	1' 1"	slate.	
	2' 8"	good coal.	
	0' 6"	slate.	
	6' 0"	good coal.	
	0' 3"	bone.	
	4' 9"	good coal.	
	0' 6"	charcoal bench.	
	3' 6"	good coal.	
	6' 0"	good coal, 5-foot bench.	
	3' 6"	coal with several seams of bone, 3-foot bench.	
	0' 6"	bone.	
	8' 0"	splendid coal.	
	51' 1"		
	Bottom slate.		

The Philadelphia and Reading Coal and Iron Company own a large tract of land in that vicinity which was formerly the property of two companies, in which the Philadelphia and Reading Railroad Company owned a controlling interest; within a year it has passed into the hands of the former company, which is really a department of the Philadelphia and Reading Railroad Company.

Fig. 1 is a cross-section of the property to be worked by the shafts at the point where they are to be sunk. Although the section may not be strictly accurate, the general structure of the basins is correct. Engineers familiar with the locality do not agree as to the exact position and number of the veins above the mammoth vein. There are three principal basins, E, C, and D, Fig. 1, to be reached by these shafts; they are separated by the two anticlinal axes or saddles A and B, the first of which, A, deepens to the west, and the other, B, rises for a certain distance to the east, and then sinks so that it is probable that gangways or levels, through which the water will drain to the shafts, can be driven in coal from C into the two basins E and D. It is proposed to sink to the bottom of basin C, and in this manner an area of big vein will be opened 1,500 yards wide and at least 4 miles long, provided it should prove economical to extend the workings to far.

Mr. Franklin B. Gowen, shortly after he was elected president of the Philadelphia and Reading Railroad Company, determined to make this large body of land available for the production of coal, the upper or red-ash veins having been worked out, and the land, to a certain extent, abandoned. He saw that it would involve a great outlay of money, and that it would take a long time to open the property, but he also saw that a colliery could be erected capable of producing daily a very large amount of coal for a long series of years. Before beginning operations, Mr. Henry Pleasants, the engineer selected to take charge of the work, made a careful study of the whole problem, the results of which were embodied in several reports to the company. He worked out the geological structure of the ground, both by an examination of the surface indications and of the old workings, so that the most favorable position for the location of the openings could be determined. There was no useless delay, but many months were devoted by him to the consideration of the various questions which would be likely to arise, and a large number of surveys both above and below ground were made. When the preliminary studies had been completed the work was begun and has been pushed rapidly to what promises to be a successful completion. This undertaking differs in this respect from most of the mining enterprises that have been started in the United States. We generally begin operations without fully understanding all that is to be done, and then solve as best we can any problems that may present themselves during the progress of the work. The latter mode of proceeding involves, of course, very often, much useless expenditure, and sometimes ends in failure. I think, therefore, that this enterprise is worthy of notice as an example of the way in which such mining operations should be undertaken.

When everything was ready, the work was begun with the best appliances, and no necessary expense has been spared to make the operation a success, although there has been no useless outlay. Mr. Pleasants at first proposed to sink a single shaft to be used both as an upcast and downcast, until another air-way could be driven out from the top of one of the anticlinal axes. In the mean time, however, the Pennsylvania mining law was enacted, and, as it requires that any mine, in which more than twenty men are employed at one time, shall have at least two openings, separated by not less than 150 feet of solid strata, it was decided to sink two shafts simultaneously. The depth to which the shafts will be sunk is estimated at about 1,500 feet, the distance depending upon the diminution of dip in the strata. If the dip of the mammoth vein in the synclinal C is slight, the depth of the shaft will be less than if its dip is steep. The dip diminishes as the distance from the surface increases. It was finally decided to sink the two shafts (known as the east and west shafts) about 700 feet apart along the strike of the central basin above the point marked C on the section Fig. 1. Fig. 2 is a topographical map showing the relative position of the two shafts A and B, the railroad which is to transport the coal, the configuration of the ground, the slope C D and gangway F D, which is driven in one of the upper veins with a slight rise, so that the water will flow from B to D. At the surface the strata is very much inclined, dipping about 70° to the north, but it is probable, as shown in Fig. 1, that the shafts will cross to the other side of the basin, and that the inclination of the strata will decrease. The east shaft (A, Fig. 2) is intended solely for raising coal; it is 16 feet long and 13 feet 10 inches wide, outside of the timbers, and will be divided into two compartments. Fig. 5 is a section of this shaft showing the timbering below the masonry. Fig. 7 is a section of the shaft showing timbering and stone-work near the surface. The compartment shown in the corner of the shaft in Fig. 7 is used temporarily for ventilation.

The west shaft (B, Fig. 2, Fig. 4, and Fig. 6) is 25 feet 8 inches long, and 13 feet 10 inches wide, outside of the timbers, and will be divided into three compartments, two of which will be used for raising coal and for hoisting men, timber, slate, rock, &c., and the other will be for some years the upcast of the collieries. A suction-fan will be used for ventilating the mines. No provision will, at present, be made for putting in pumps, for the following reasons: In this part of the anthracite coal-field, very little water is met with, when a depth of 500 feet from the surface has been reached, unless the superincumbent strata have been fissured and broken by mining out the veins below that level, so that for a long time the little water that will be met with in the mines can be raised by the winding engines at night, tanks being substituted for the cages. When the underground workings have reached the tops of the anticlinals, one or more air-shafts will be sunk to them, and after they are finished, the third compartment, being no longer required for ventilation, can be used for the pumps, should they become necessary. There will be ample room in it for pumping-machinery of the largest kind.

Fig. 3 is a cross-section of the east shaft and Big Tracey vein, which (as is also shown on Fig. 1) will be cut by both shafts about 400 feet below the surface. A slope has been sunk on this vein (see C D, Fig. 2, and also Fig. 1 and Fig. 3) nearly to the point where it will be cut by the shafts. From the foot of the slope a gangway (D F, Fig. 2) has been opened at that level in the vein, and from it the cross-cuts E A and F B (Fig. 2) have been driven to the points through which the shafts, when sunk, will pass. A hole has been bored in the bottom of the east shaft to the cross-cut E A, Fig. 2, by the method to be explained further on, through which the water that accumulates in the shaft finds its way to the sump at the bottom of the slope, from which it is raised to the surface by a Cameron pump. A hole is now being bored for the same purpose in the West shaft to the cross-cut F B, Fig. 2.

Fig. 3 also shows the masonry and brick-work in the east shaft, and Fig. 3 *a* those in the west shaft. In the east shaft (see also Fig. 7) there is a wall of cut stone 4.5 feet thick and 16.3 feet high built upon the solid rock, and above this a brick wall 4.5 feet thick and 16.8 high. The space (about 2 feet wide) between the masonry and brick-work and the alluvium is filled with puddled clay, by which the infiltration of the surface-water is prevented and the walls of the shaft protected from its destructive action.

As the strata upon which these walls are built are highly inclined, (from 70° to 80°,) it was necessary to put in below the masonry four sets of iron girders, such as are shown in Fig. 13 and Fig. 14, in order to prevent wedges of rock from being pressed out by the superincumbent weight. The west shaft, see Fig. 6, is walled up in the same manner, but the brick-work is 43 feet high and 4 feet thick, and the masonry is 8 feet high and 4 feet thick; under the masonry there are seven sets of iron girders similar to those represented in Fig. 13 and Fig. 14.

When the two shafts pass the level of the cross-cuts from the gangway, F D, Fig. 2, water-tight troughs cemented around the sides of the shaft will be put in, by which all the water entering the shaft above that level will be caught and conducted into the slope and from there raised to the surface. It is not thought probable that much water will be met with in sinking below this level, but that all which will accumulate can be raised in the buckets with the rock, &c.

The two shafts are so located that they will cut the mammoth vein at about the same level, not exactly in the center of the basin, as there is always an advantage in having a certain amount of coal below the bottom of the shafts for pumps, &c.

We now come to the consideration of the most interesting and novel part of the work, *i. e.*, the method employed for blasting out the rock. It was determined to dispense with the use of hand labor in drilling the holes for blasting, and the diamond drill was chosen as the best instrument for the purpose.

This had already been done in other places, but Mr. Pleasants decided, after careful consideration of the subject, to try a new plan of working with the diamond drill, which had been suggested to him. The plan was to sink the shaft, as usual, down to the solid rock, and then, by means of a number of diamond drills, each driven by its own machine, to bore a series of holes about 300 feet deep, which should be so arranged as to dispense with further drilling for blasting, until that depth had been reached. Fig. 4 and Fig. 5 are plans of the two shafts, showing the number and positions of the holes in each. In the east shaft twenty-five holes are used and in the west shaft thirty-five. In each shaft one of the holes was bored down as quickly as possible until it reached the cross-cut from the gangway and slope, and in this way not only the water which drained into the shaft from the surrounding strata, but also that which had been used in the drilling, found its way to the slope, and was then pumped to the surface.

DESCRIPTION OF THE MACHINERY USED IN DRILLING.

The bit used in drilling is shown in Fig. 11 and Fig. 12. It differs from the ordinary diamond-bits in being concave instead of convex. The circular grooves and the small cylindrical holes are for the outlet and circulation of the water, which is forced down through the center of the boring-rods. The rods are made of gas-pipe, one and a half inches in diameter outside. The water takes up the fine sand or pulverized rock, carries

Fig. 3.

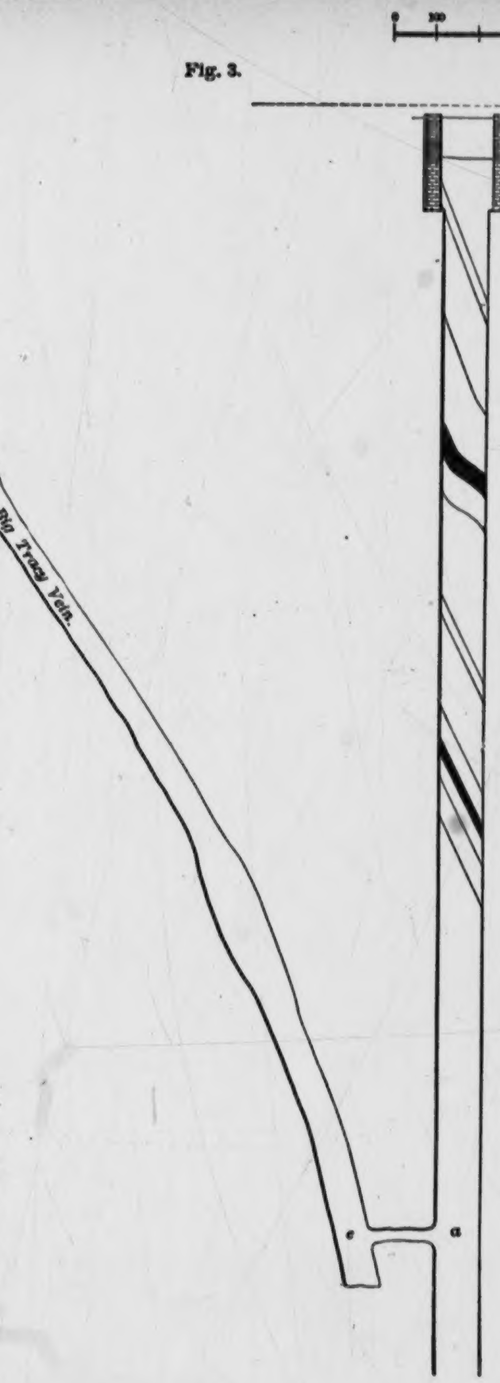
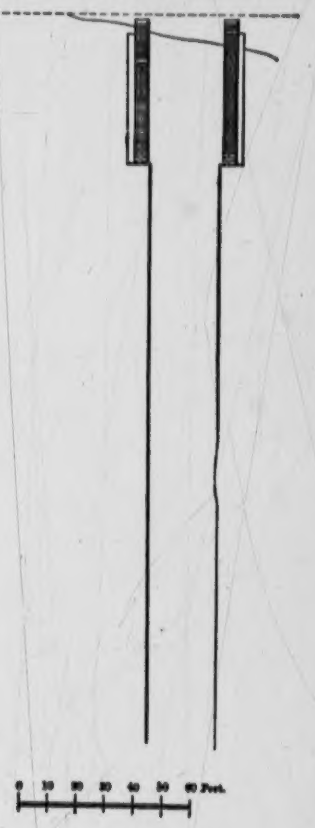


Fig. 3a.



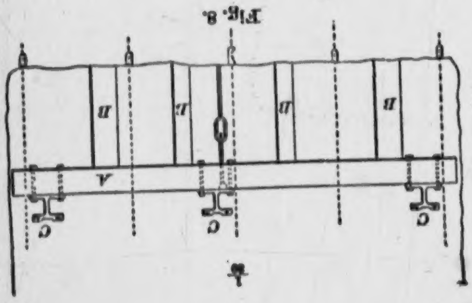


Fig. 8.

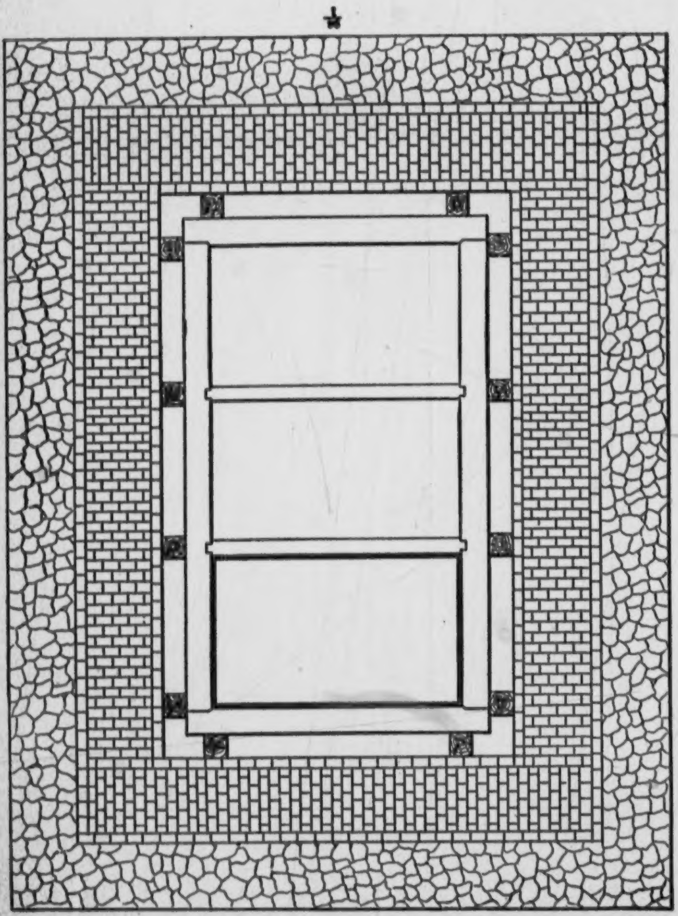
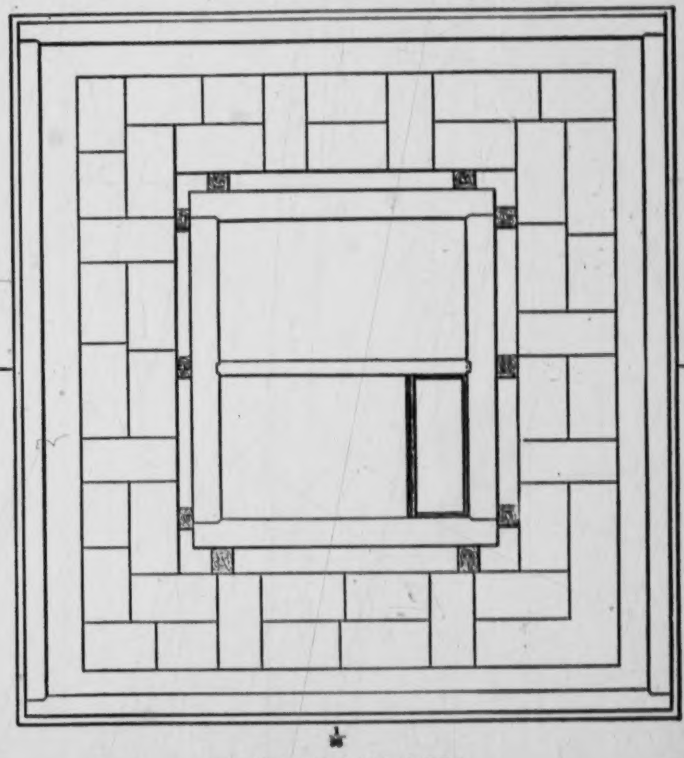


Fig. 6.

Fig. 7.



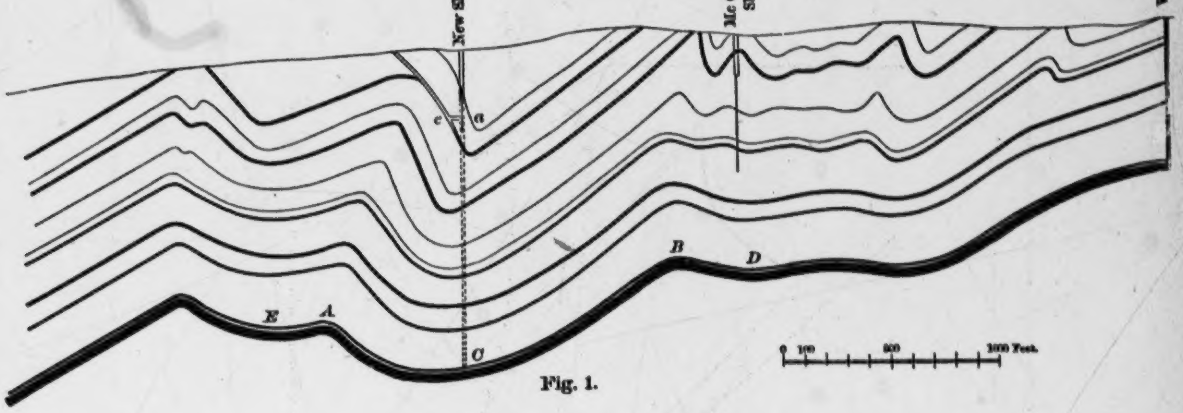


Fig. 1.

$\frac{1}{96}$

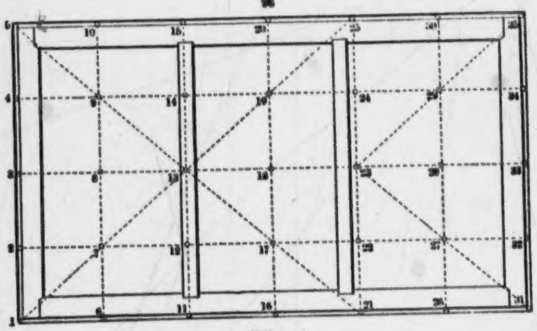


Fig. 4.

$\frac{1}{96}$

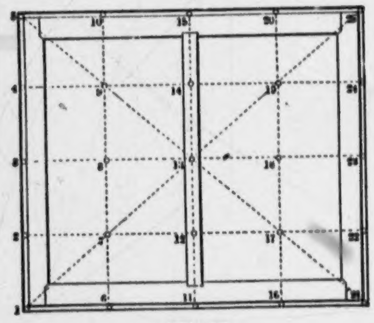


Fig. 5.

$\frac{1}{4800}$

Fig. 2.

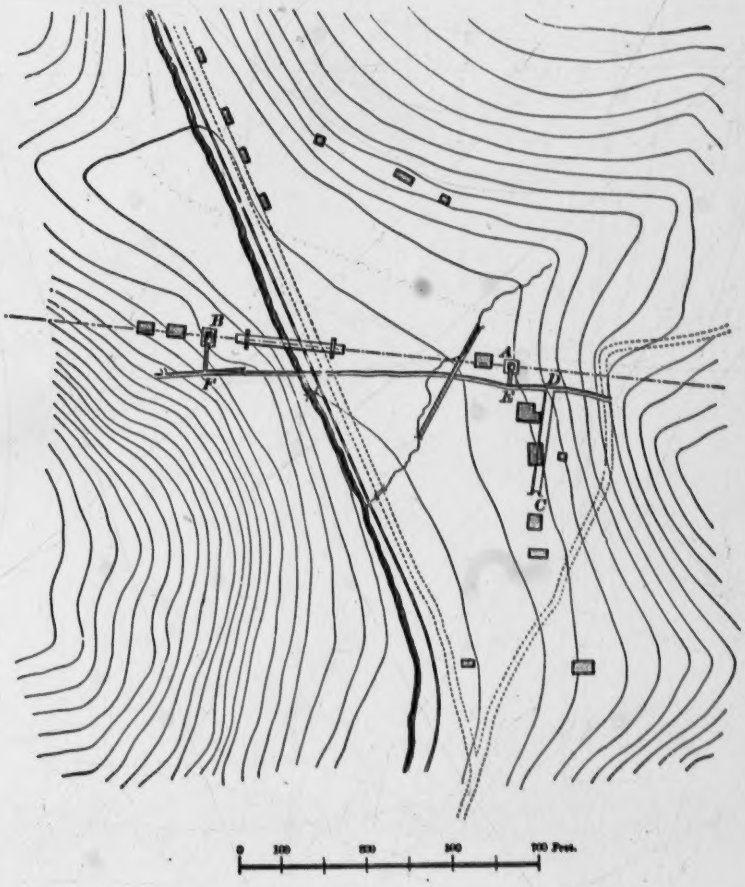


Fig. 3.

$\frac{1}{120}$

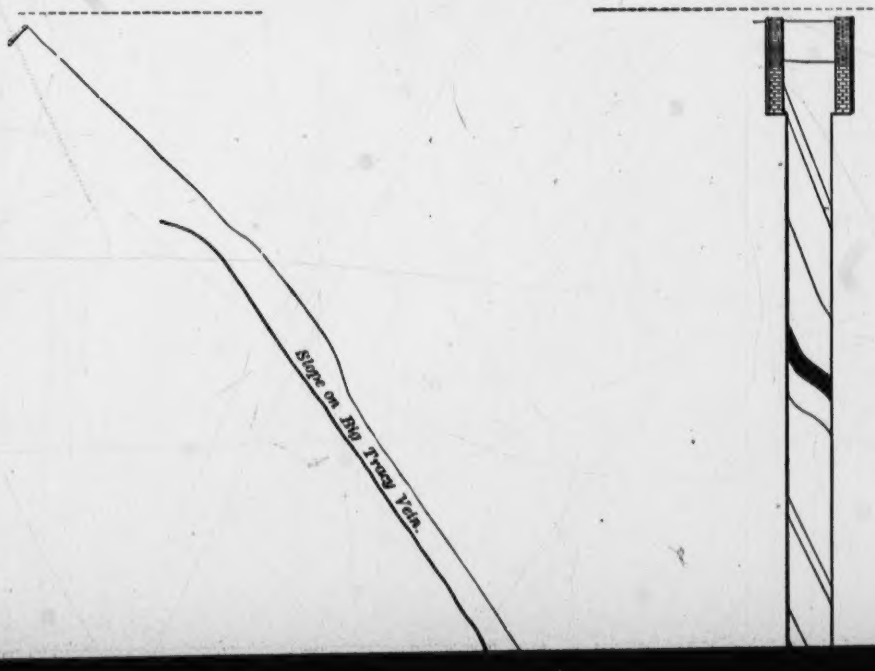
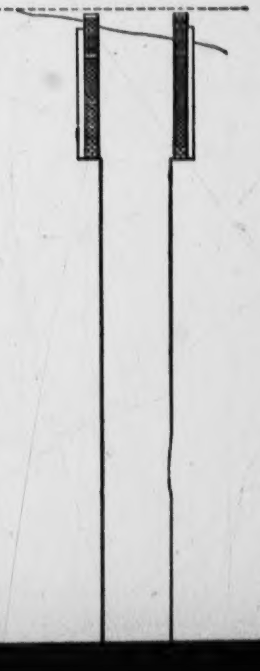


Fig. 3a.



it away from under the bit, and then rises on the outside of the rods or pipes to the surface. The water is supplied under pressure to the rods either by a common pump or by bringing it from a height, (the tops of the shaft, for example,) which is sufficient to produce the desired pressure. The machine used for drilling is much more compact and simple than the old diamond-drill apparatus. A Root rotary engine has been substituted for the two oscillating cylinders which turned the drill. The arrangement of the machine is shown in Fig. 15, Fig. 16, and Fig. 17.

The main shaft, A, Fig. 17, of the rotary engine carries a bevel pinion, B, which gears into another bevel pinion, C, upon the sleeve D, through which the boring-rod passes and to which it is fastened. The lower end of the sleeve has a screw cut upon it, by means of which the drill is fed. Upon the upper end of the sleeve D a key-seat of from four to six feet in length is cut, (the distance depending upon the length of the sections of the rods;) over this sleeve a pinion, M, Fig. 15, also key-seated, is slipped. A key, hanging loosely in the key-seats, causes D and M to revolve together. This pinion M gears into another pinion, N, Figs. 15 and 16, which is slipped upon the head of the shaft P, Fig. 16, which has a feather on it. Upon the lower end of P is fastened a third pinion, O, that drives a fourth, Q, which forms the nut of the screw of the sleeve D. This nut is so fastened to the machine that it can turn, but cannot move in the direction of the axis of the sleeve. If the pinions M and N are of the same diameter, the nut makes the same number of revolutions as the screw, and the rod does not advance; but if the diameter of N is larger than that of M, the nut makes fewer revolutions than M, and the rod moves downward. By changing the dimensions of M and N the drill can be fed at any desired rate. The part of the machine which carries the drilling-apparatus can, by unscrewing a few bolts, be turned round the shaft of the engine, so that it can be used for drilling either vertically, horizontally, or at an angle. It is not necessary to dwell upon the construction of the drilling-mechanism, as it does not differ from that of the ordinary diamond-drill machines.

Figs. 18 and 19 show the apparatus used for drawing up the rods. It consists of a Root engine, D, similar to the one used for drilling, upon the shaft EF of which a small pinion is keyed. This drives, by means of the small cog-wheel B, the grooved drum C, around which is wound a small wire rope, that draws up the rod.

The west shaft has seven rows of five holes each, as shown in Fig. 4, and the east shaft (see Fig. 5) has five rows of five holes each. The method adopted for boring the holes was the same in both shafts. I shall therefore describe in detail the operation for the east shaft only. At the points where the boring-machines are put to work the cross-section of the shaft is made a little larger than it is elsewhere, so that the machine can bore the holes in the corners and along the sides of the shaft. Two heavy timbers or sills, A A, Fig. 8 and Fig. 9, are then laid across the shaft about three feet above the bottom, and supported by the upright posts, B B B B; upon these timbers are placed three cast-iron bed plates, C C C, Fig. 8 and Fig. 9, (see also on a larger scale in Fig. 10,) upon which the drilling-machines can be made to slide until the axis of the drill is vertically over the point where the hole is to be bored. The machine is then fastened down by bolts, the heads of which fit in the grooves on the bed-plate. As soon as the first hole has been bored to the required depth the machine is moved to the next. Two or three machines can work at the same time on the same bed-plate. When the five holes in the first row have been bored, the bed-plate is moved to the next row. The operation is continued until all the holes in the shaft are drilled. A large quantity of water is required for drilling, as a constant stream of it, filling a pipe about half an inch in diameter, must be forced down through each of the boring-rods. The water passes through the center of the rod, takes up the fine sand produced by the action of the machine upon the rock, and carries it up on the outside of the pipe or rod, which is smaller than the hole.

In boring the first set of twenty-five holes, this water was brought from the surface and was returned to it, when it had become dirty, by a steam-pump. Two small Cameron steam-pumps were employed for forcing the water down the rods and raising the dirty water to the surface. After the first hole had been drilled, so as to open a way for the water into the cross-cut from the slope, the water which collected in the shaft and that which had been used for drilling found its way through this hole to the pumps in the slope. When the shaft becomes deeper, the intention is to use the same water over and over again for drilling by pumping it into a settling-tank, placed from 200 to 300 feet above the bottom of the shaft, in order to get head enough to force the water with the required velocity through the rods. The tank will be divided into two parts, so that the water can be partially filled in passing from one to the other. It is essential to remove any oil which the water may take up in its passage through the rods or which may fall in it from the machinery, as the oil solidifies or gums, and clogs the holes in the bit through which the water passes out from the center of the rods. It is not necessary to remove all the fine particles of pulverized rock which the water may bring up, unless it is important to know the exact nature of the strata in which the drill is working.

The average rate of drilling, as shown by the following table, is from 30 to 40 feet a day for each machine.

Statement of drilling done at east shaft of East Norwegian Colliery, on lands of Mammoth Vein Coal and Iron Company.

Number of machine.	Date when started.	Date when finished.	Depth of holes.		Number of machine.	Date when started.	Date when finished.	Depth of holes.	
			Feet.	*Inches.*				*Feet.*	*Inches.*
1	January 17..	February 1...	334	5	14	February 24...	February 27...	200	4
2	January 17..	February 1...	318	11	15	February 26...	March 6...	293	0
3	January 31..	February 8...	200	8	16	March 1...	March 7...	254	8
4	February 3..	February 9...	198	7	17	March 1...	March 9...	279	0
5	February 6..	February 12...	200	0	18	March 1...	March 11...	290	0
6	February 12..	February 17...	197	2	19	March 5...	March 14...	295	3
7	February 13..	February 22...	205	2¼	20	March 8...	March 19...	295	0
8	February 15..	February 23...	179	2	21	March 9...	March 16...	307	4½
9	February 19..	February 24...	205	2	22	March 9...	March 18...	298	0
10	February 20..	February 27...	205	2	23	March 13...	March 20...	281	7
11	February 21..	February 26...	200	8	24	March 15...	March 23...	295	0
12	February 23..	February 28...	201	5	25	March 16...	March 23...	301	2
13	February 24..	March 6...	312	0					

Greatest number of drilling-machines used	7
Average number of drilling-machines at work	3
Average drilling done per day of 24 hours by each machine	34 feet.

The machines often work much faster, but there are incidental delays. Seven machines are at present employed, and as there are no cores to be removed, all the rock being ground to powder and carried off by the water, it is not found necessary to take out the rods very often. Steam is now used to drive the boring-machines and the pumps, but preparations are being made to use compressed air in the lower levels, partly because the use of steam would render the shaft uncomfortably warm, and partly because there would be great danger of injuring the men in case any accident should happen to the steam-pipes. A fan has also been erected for the purpose of ventilating the shaft.

When all the holes are bored to a depth of from 250 to 300 feet, the machines, pumps, &c., are taken to the other shaft to bore the holes in it. During the boring in one shaft, the rock is blasted and removed in the other. There is always time to spare, as 300 feet of holes can be drilled much more quickly than the shaft can be sunk through the same distance in rock. The diameter of the holes is in all cases 1¼ inches. On the completion of the holes they are filled to the top with sand, and the work of blasting and removing the rock begins. The operation of blasting is conducted as follows: The miner, by means of a small pump, such as is used with ordinary boring-rods, removes the sand from the holes Nos. 7, 8, 9, 12, 13, 14, 17, 18, and 19, of Fig. 5, to a depth of from 3 to 4 feet; clay is then forced into each hole, so as to make a plug from 6 inches to a foot long, and on the top of this a cartridge of dualin is placed, and the holes are then tamped with clay. The cartridges are connected together by wires leading to a galvanic battery, and they are all fired at once. The explosion is produced by a cap filled with fulminate of mercury. The result of the simultaneous discharge of these nine holes is the formation of a large cavity in the center of the shaft to the depth of the bottom of the cartridges. The rock loosened by the operation is removed, and the remaining holes are then charged and fired in the same way, those on each side together, but only one side at a time. It should be noted here that powder is not effective in vertical holes. Dualin, dynamite, or some other of the nitro-glycerine compounds must be used, particularly where the strata are nearly vertical and to a certain extent fissured. The sides of the shaft preserve their proper form, and no hand-blasting is necessary for trimming them up. When all the holes around the shaft have been fired, the miner begins again with the nine central holes, and the work goes on in this manner until the depth to which the holes have been bored is reached; the machines are then set to work again and the holes are bored from 250 to 300 feet deeper.

The holes in that part of the shaft which has been sunk preserved their vertical direction until they reached a small vein of coal, where, although remaining in the vertical plane at right angles to the strike, they were deflected toward the floor of the vein, as shown in Fig. 20, the angle of deflection being about 2°. This deflection is due to the fact that when the drill reached the top of the vein, which dipped at an angle of about 60° and was softer than the rock, it inclined toward the side offering the least resistance. Thus far the deflection has been so slight, that it was only necessary, after the nine central holes had been fired, to put a larger charge of dualin in the holes on the side CD than in the vertical holes, and a smaller charge

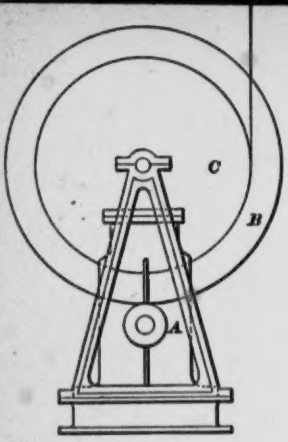


Fig. 18.

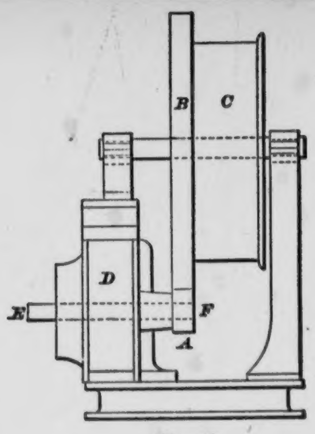


Fig. 19.

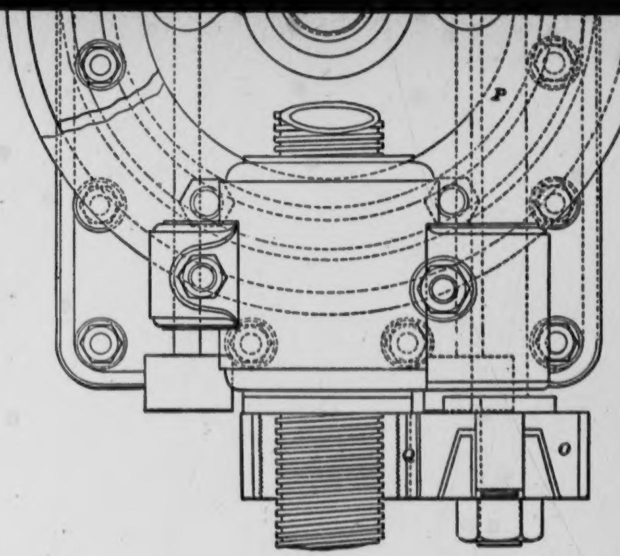


Fig. 16.

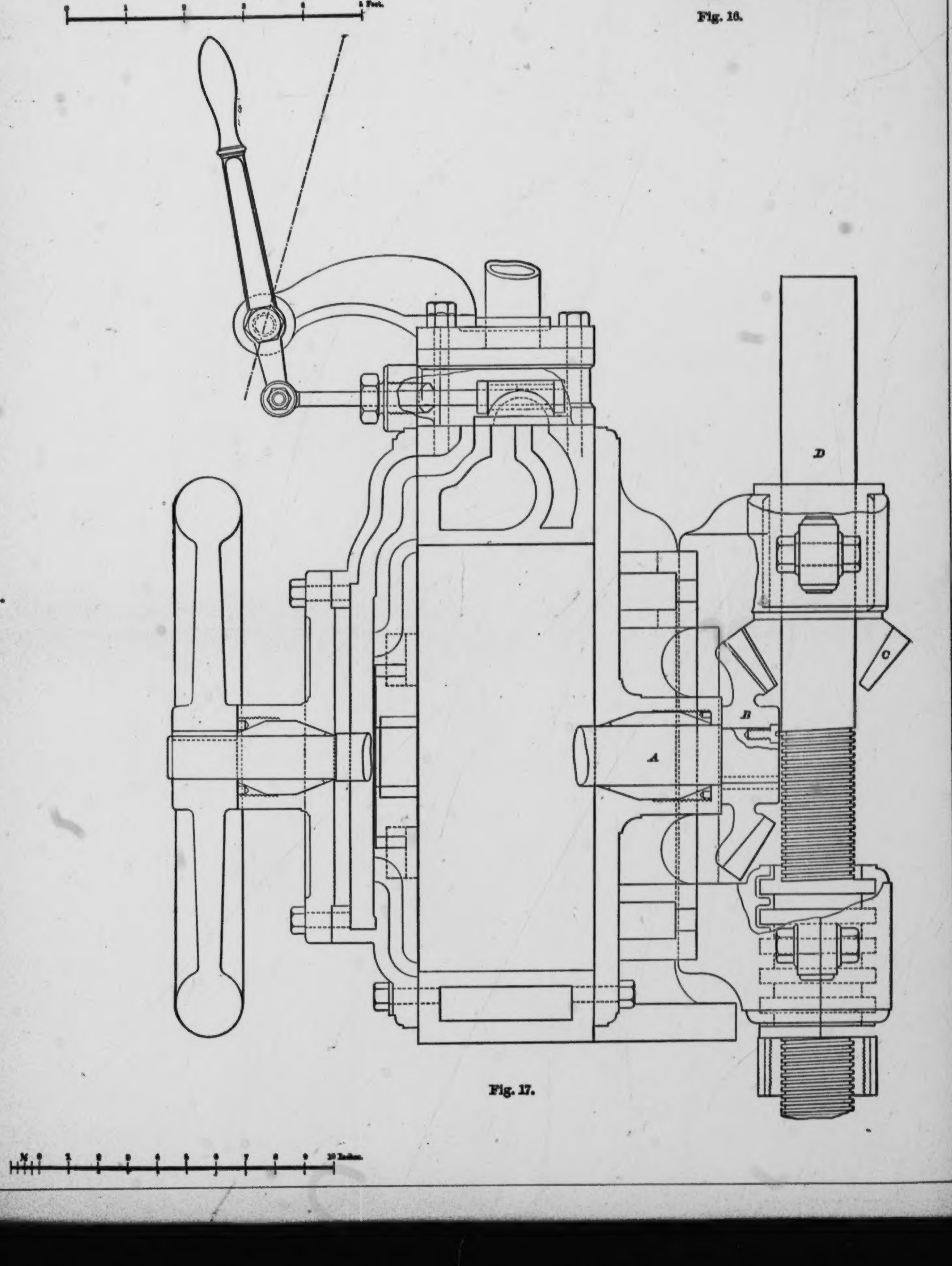


Fig. 17.

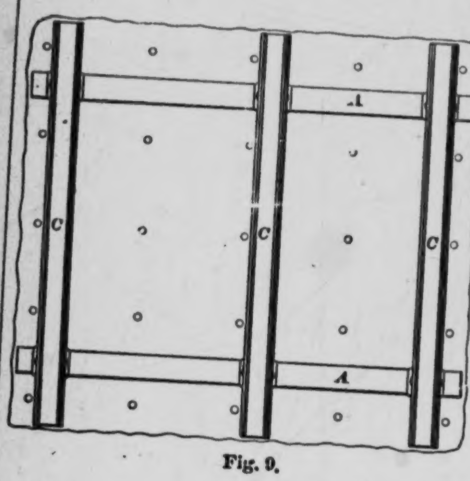


Fig. 9.

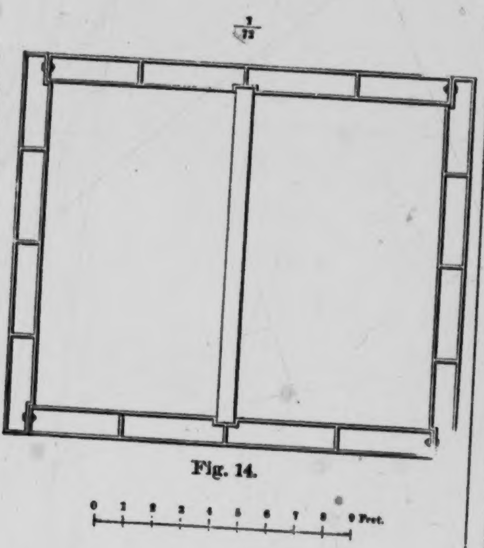


Fig. 14.

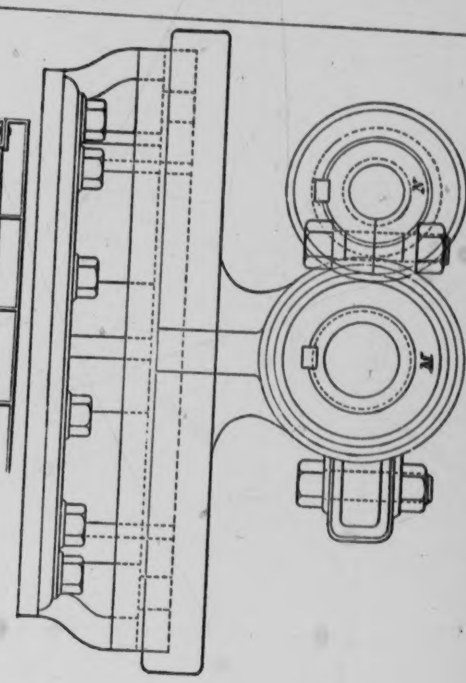


Fig. 15.

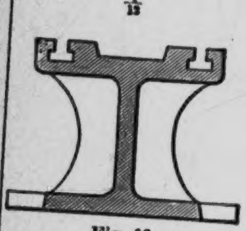


Fig. 10.

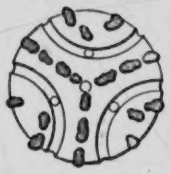


Fig. 11.

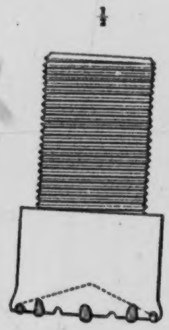


Fig. 12.

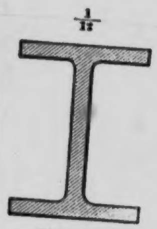


Fig. 13.

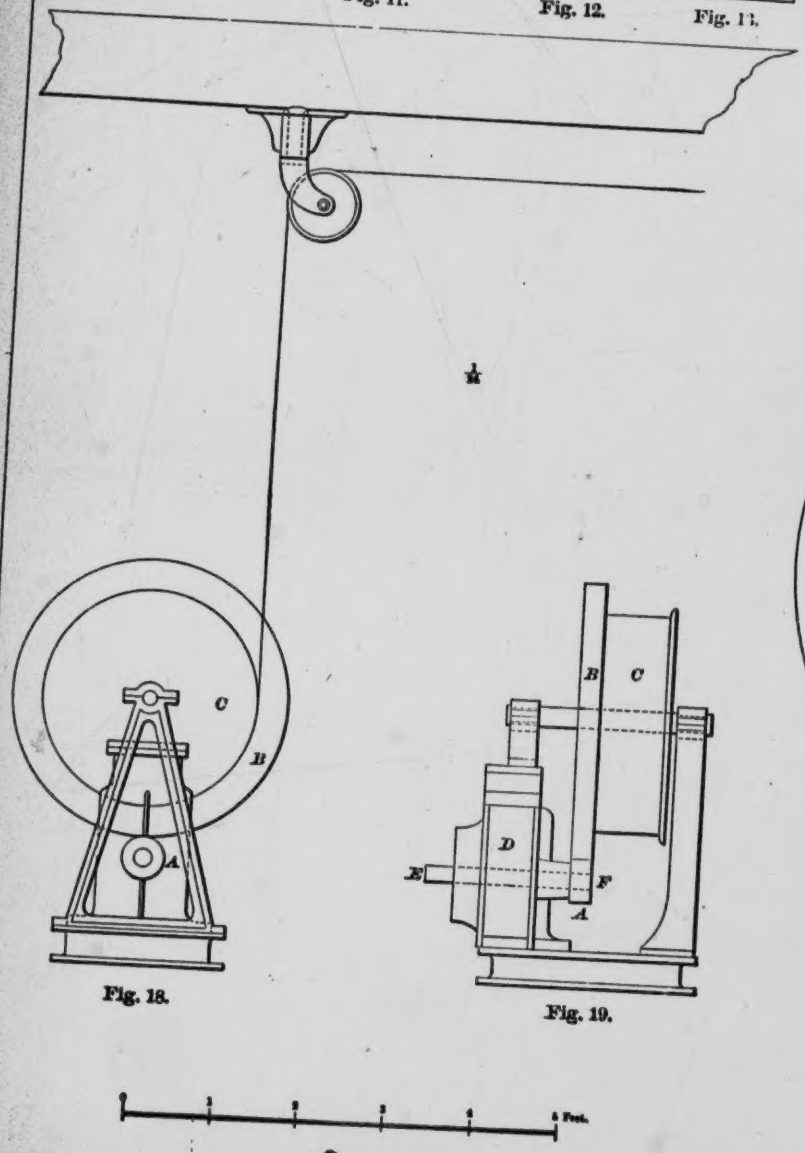


Fig. 18.

Fig. 19.

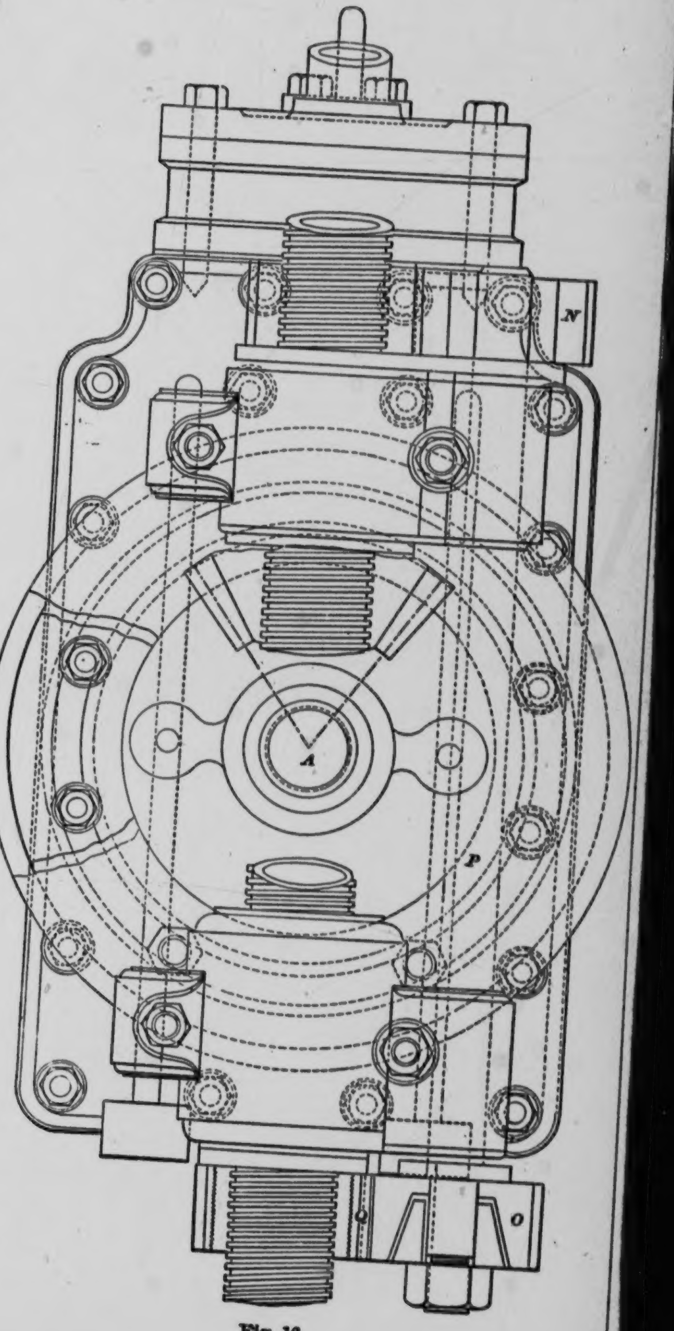


Fig. 16.

in the holes on the side AB. In the first case (CD) the dualin shattered the rock behind it, and it was possible to keep that side of the shaft vertical without resorting much to hand blasting. In all other parts of the shaft the holes went down in a perfectly vertical direction. The corners of the shaft are exactly where the four corner holes went down, and the sides of the shaft look as if they had been trimmed up, although in reality nothing of the kind has been done. The sides have very much the appearance of a stone which has been broken by a plug and feather. The shaft is timbered as the work proceeds, yellow pine timber 12 inches by 12 inches, placed at first skin to skin, and afterward 2 feet apart, being used below the iron girders. The guides are of California yellow pine, and are put in as the work proceeds. The bucket used for taking out the stuff will be guided as is shown in Fig. 25. Two buckets will be used, and there will be shields above them to catch anything that may fall in the shaft, (see Fig. 24,) so as to protect the workmen. The bucket is made of iron, holds from one to two tons of rock, and has two trunnions placed opposite to each other, a little above its center of gravity. When the bucket is raised to the surface, a truck (Fig. 21, Fig. 22, and Fig. 23) is run under it, on a railroad passing over the shaft, and the bucket is then lowered into the Y-shaped rests. The rests are supported on a turntable, which allows the bucket to be revolved in a horizontal plane, and, by means of the lever A, the bucket, being suspended nearly at its center of gravity, can easily be overturned and emptied. This apparatus is simple and works admirably. By having several trucks and buckets, the stuff can be hoisted and disposed of very quickly.

In the east shaft, with eight machines, the twenty-five holes can be bored in about one month. In the west shaft, with from eight to ten machines, the thirty-five holes can be drilled in about six weeks. The east shaft was sunk from April 15 to May 15 of this year (1872) 76 feet, and during this time twelve days (five in April and seven in May) were lost; that is to say, there was no blasting done from want of timber and from want of fresh air, in consequence of the brattice not having been built near enough to the bottom of the shaft. In blasting in the east shaft, two miners, three laborers, and one chargeman are employed on each shift. There are three shifts of eight hours each per day.

In the first 300 feet drilled in the west shaft the rock was hard; in the east shaft it was principally soft rock and slate. The plan of boring the holes to a depth of 300 feet at once, filling them with sand and then using portions of them, as wanted, for blasting, was first suggested by Mr. Shelley, formerly superintendent of the William Penn Colliery, in Schuylkill County. Mr. Bullock, formerly superintendent of the Pennsylvania Diamond Drill Company, took up the idea, and suggested it to Mr. Pleasants. After carefully considering the question and testing it, Mr. Pleasants recommended Mr. Gowen to sink the two deep shafts with the diamond drill in this manner, and upon his advice the company decided to try it. After this indorsement of Mr. Pleasants and the decision of the company, Messrs. Shelley and Bullock patented their process of "drilling deep holes, filling them with sand, and firing them in sections." The patent now belongs to the Pennsylvania Diamond Drill Company.

As soon as he had decided to use this process, Mr. Pleasants became satisfied that the form of engine then employed with the diamond drill was too large and unwieldy for use in the confined space at the bottom of a shaft, where several of them would be in operation at one time. He therefore determined to use the Root rotary engine to drive the drill, and employed the superintendent of the Pennsylvania Diamond Drill Company, Mr. Bullock, to carry out his ideas of a small compact drilling-machine, to be attached to such an engine. The plan, when completed, was submitted to two of the best machinists in Schuylkill County, who suggested some slight modifications. The plan finally adopted has been given in what precedes. Nine of these machines have been constructed by Messrs. Allison & Bannon, of Schuylkill County, for this work. It is, of course, impossible to determine what will be the exact cost of sinking by this method until the work has proceeded much further. The estimate of the cost of the two collieries has not been made public, being, I believe, a confidential communication to the company. As neither the depth of the shaft, nor the exact nature of the strata to be passed through were known, it could only be approximate. Mr. Pleasants, however, informed me that he did not consider that the cost per foot of sinking by this method would necessarily be less than by the old one. The great advantage, he says, will be in the saving of time, which, he thinks, will be fully 50 per cent.; this is, of course, a consideration of immense importance in an operation involving the outlay of so much money. Another advantage is that most of the men employed need not be skilled miners. Mr. Pleasants considers that the method will be employed with peculiar advantage in sinking shafts of moderate depth, (from 200 to 300 feet.) In such cases, after a shaft has been sunk through the earth, clay, or wash, to the rock, the machines can be put to work on the surface, and the holes bored down to the depth which it is intended to reach by the shaft. The shaft can then be sunk without any hand-drilling. The great advantage of this method, where the strata to be penetrated contain large quantities of water, is self-evident.

APPENDIX.

Since the foregoing paper was read, and before its publication, I again visited the shafts, and obtained on April 25, 1873, the following additional data:

The east shaft has been finished to a depth of 530 feet, and the holes for 200 feet more have been drilled. The west shaft has been finished to a depth of 400 feet, and they are beginning to bore the next set of holes. During the last six months the east shaft has been sunk on an average over 60 feet per month. In one month 80 linear feet of the shaft was blasted and timbered.

The permanent guides have been put in place in the east shaft as far as it has been sunk. The two shafts have been connected on the surface by a railroad. Six machines are used in the east shaft for boring. In place of the screw-feed described in the foregoing paper, a new hydraulic feed has been tried with success. The revolving sleeve is placed between two cylinders, in which two pistons, connected with the lower end of this sleeve, move; by admitting water, under a greater or less head, by means of a stop-cock, the drill can be moved forward, as fast or as slow as may be wished, with any required pressure. The shaft has passed the level of the cross-cut, and the water in the shaft has been cut off by forming water-tight gutters around the shaft upon one set of timbers, and from them the water is conducted to the slope. There is not water enough met with below this level to keep the timbers wet. If the slope were not there, and the water had to be pumped from the bottom of the shaft, it would require five lifts of pumps, a Cornish engine, rods, pumps, &c., to raise the water from the bottom of the shaft when the work was completed.

A double-acting Alison & Bannan steam-pump, with fourteen-inch plungers, has been put into the slope, replacing the Cameron pump.

A double-acting Waring compressor has been erected, by which from four to five of the drilling-machines and the steam-pumps in the shaft can be driven. Some of the drilling-machines are actuated by steam in order to prevent the temperature in the shaft from being too much lowered.

At the Ellangowan Colliery, near Mahanoy City, belonging also to the Philadelphia and Reading Coal and Iron Company, a shaft is now being sunk which will not exceed 300 feet in depth. The holes for the blasting have all been bored from the top to the bottom in one operation.

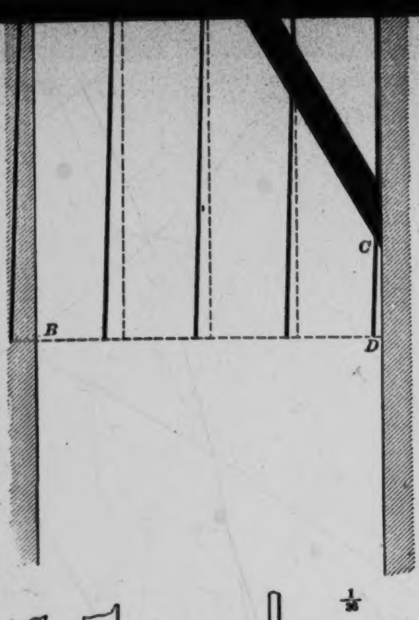
The east shaft, which was originally on the south side of the basin, has passed the synclinal and is now cutting through the south-dipping strata, the dip being about 30°. This was predicted by Mr. Pleasants, as may be seen by his section, Fig. 1, which was made at least a year before the shafts reached the synclinal.

CHAPTER XXIII.

THE DEFECTS OF THE MINING LAW.

The following essay on the mining law, together with comments upon the great lawsuit of the year, between the Raymond and Ely and Pioche mining companies, was written, at my request, by Mr. W. S. Keyes, mining engineer, of Eureka, Nev. I publish it without intending thereby to express a full concurrence with his views; although, of course, if I did not think them entitled to weight, I should not have given them place in these pages. Of the merits of the litigation in Pioche I know nothing, and I print this account of it merely as an illustration of what may arise under our laws. It should be pointed out, however, that the complications and troubles of this case were really legacies from an earlier period, and the titles originating under the present law cannot be affected with the same uncertainty. It is evident that Mr. Keyes favors the Hermes party in the case. I believe he was an expert witness on that side. My own sympathies were the other way, on grounds which seemed to me equitable; but the case is settled and half forgotten, and I feel assured that no bitterness of feeling will be aroused by this allusion to it for a purpose disconnected with either litigant. Before deciding to use Mr. Keyes's account, I wrote to the other party, inviting a statement

Fig. 21.



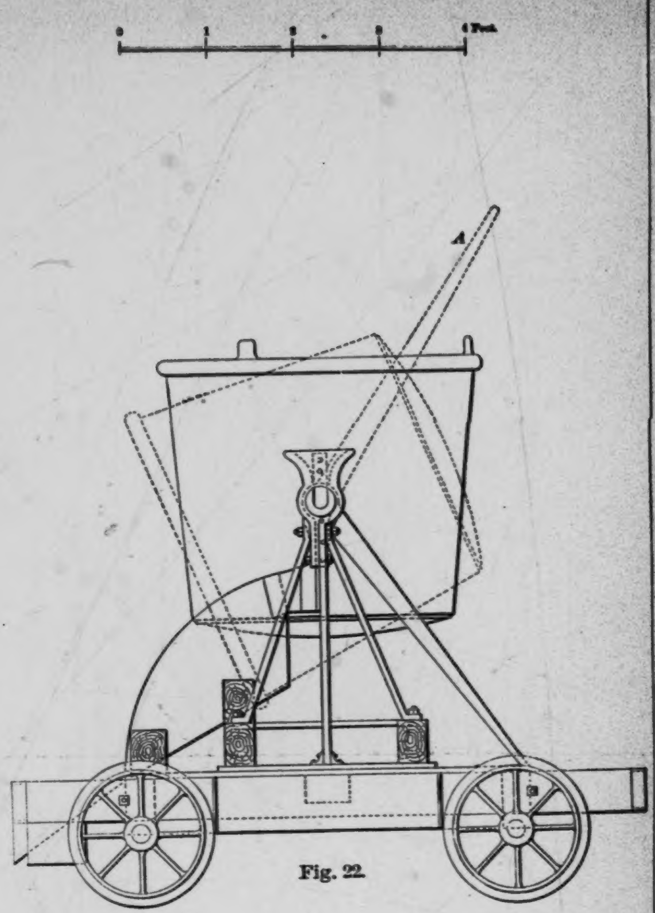


Fig. 22.

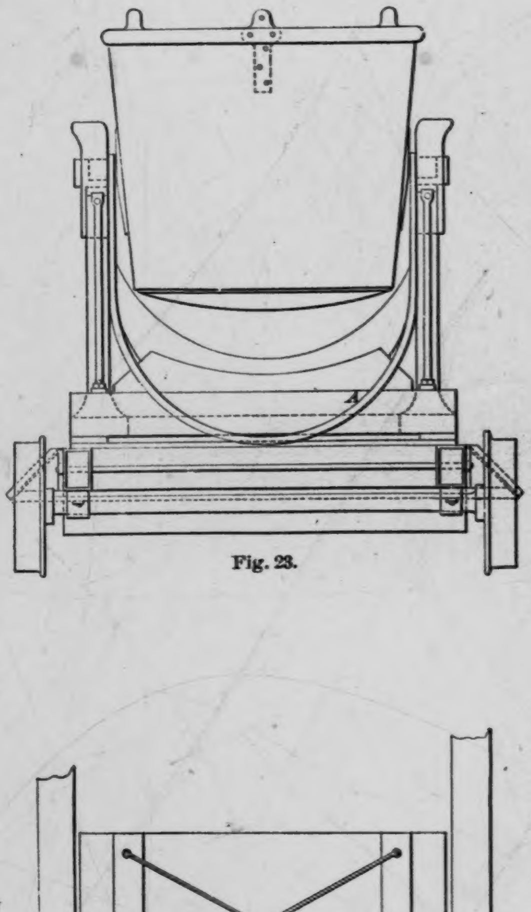


Fig. 23.

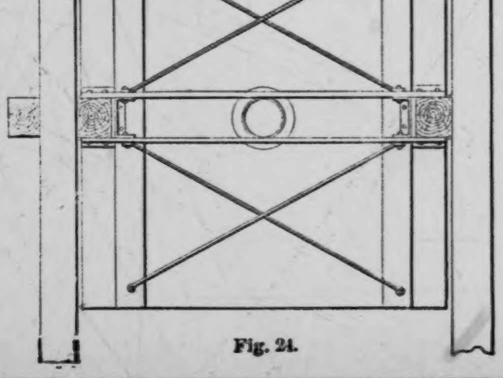


Fig. 24.

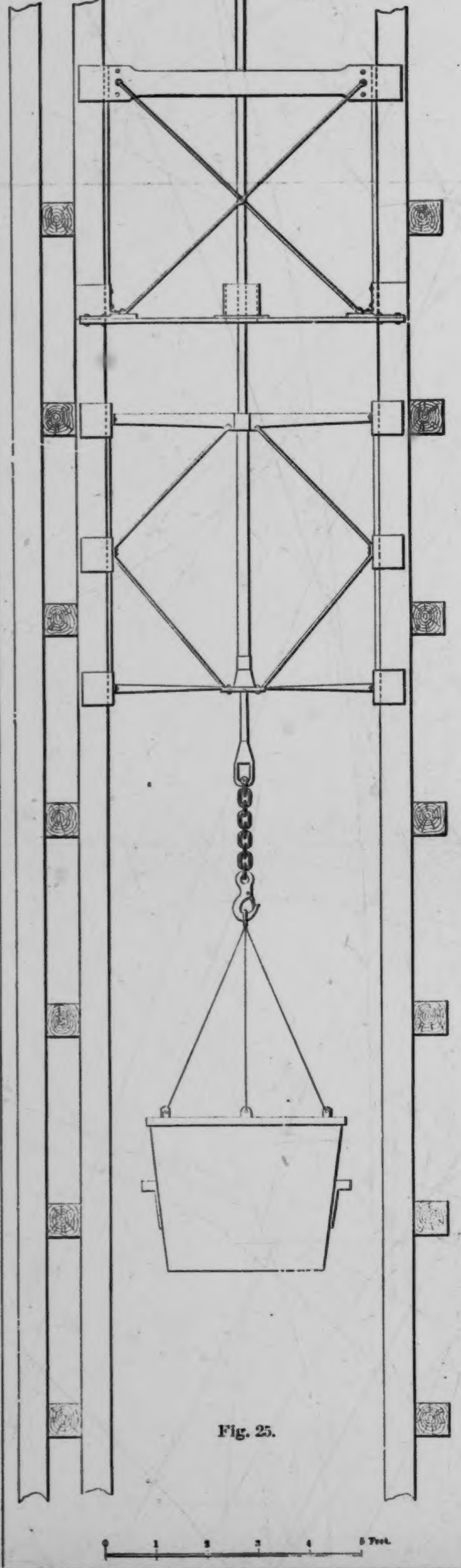
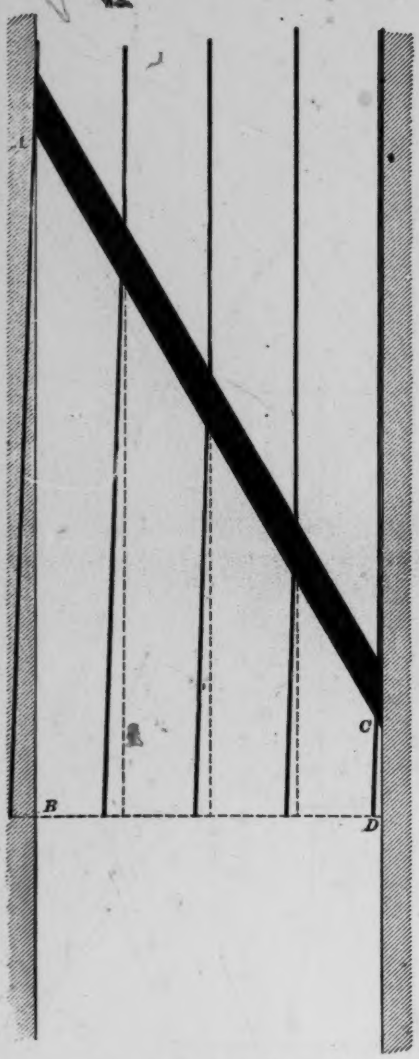


Fig. 25.

Fig. 20.



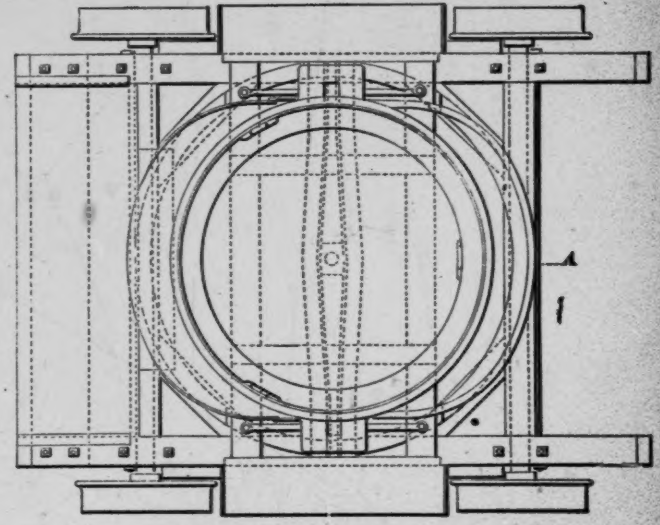
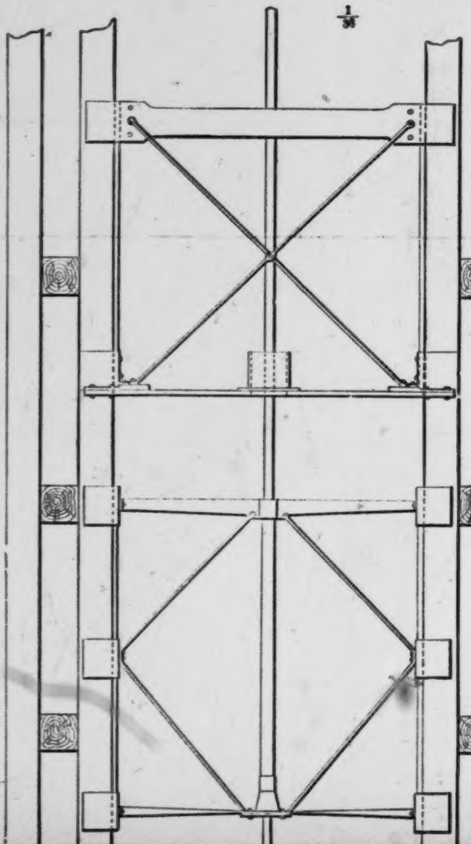


Fig. 21.



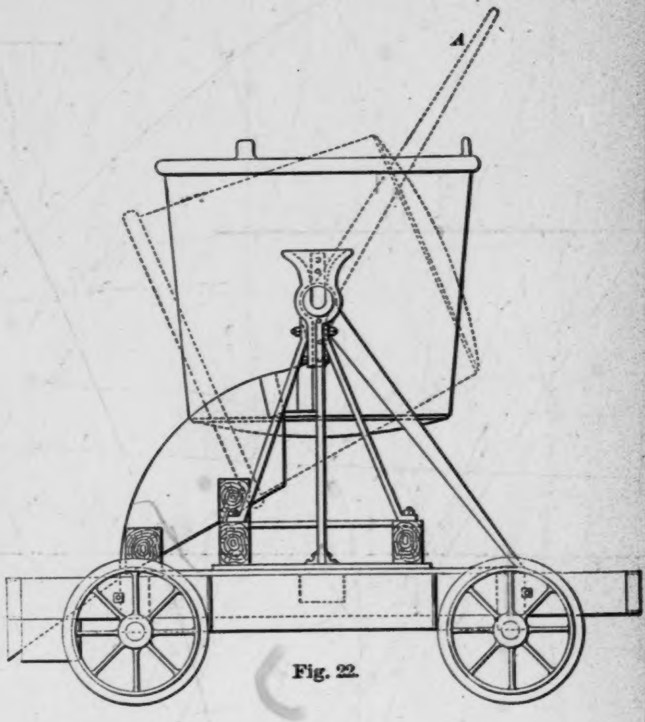
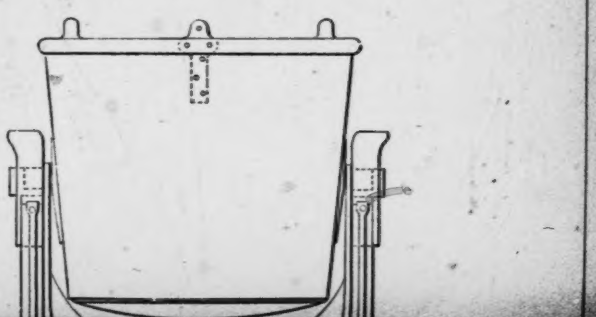


Fig. 22.



from that stand-point; but their interest in the matter was not sufficient to inspire an answer to the letter, and I am therefore confirmed in my opinion of their indifference.

The United States mining law of July 26, 1866, will be admitted by all who have witnessed its practical operation to have been a failure, and my *critiqué* thereon, in the report of the commissioner for 1868, will, I believe, be found to have been fully borne out in the light of subsequent events.

The total absence of all system, which is an inseparable concomitant of the loosely worded and often unintelligible and contradictory "local rules and customs of miners," has had its legitimate result.

Mine-owners in good faith have never, within my knowledge, in a single instance, been able to develop a good paying property without being obliged either to buy up countless conflicting and really abandoned claims, or to suffer such harrassing and costly litigation as to have rendered even the best of mines a generally ruinous investment. This state of affairs, only too patent to all who have had practical experience in our mining regions, needs here no further elucidation. It may all justly, I think, be attributed to the blundering rules and customs of a generally ignorant body of prospectors, sanctioned and perpetuated by the Congress of the United States.

The only good which, in my humble judgment, has been accomplished by the law of 1866, was the legalizing of what would otherwise have been a trespass upon the public land of the nation. Such, however, had become the force of custom, as regards possessory title to mineral-bearing land, that no government would have deemed itself justified in withholding its assent to the equity of the usage, or in so far disregarding the popular will as to have permitted the application of the then existing land laws to the totally changed condition of affairs. The law of 1866 was fatally deficient in two very important particulars: First, in not providing for a strict determination of what should constitute abandonment; and, secondly, in failing to prohibit prospecting within the surface-lines of an already located claim.

An attempt has, however, been made to remedy these defects by the amendments of 1872, which may be considered ample, as far as regards the second objection, but is wholly inadequate as regards the first.

It would surprise any one not personally cognizant of the facts, to see the multitude of apparently legitimate locations piled the one on the top of the other and covering substantially the same vein or ore-body; and, however perfect may appear the "paper title," to understand how difficult it is for any searcher of records to find out whether any given claim was ever really made where it purports to have been located, or whether it was floated, *i. e.*, fraudulently transported from another portion of the district, often miles distant.

Such a state of things left the door wide open for every species of blackmail, perjured testimony, and suborned witnesses to pull down and ruin legitimate mining enterprises, and to throw on the pursuit the very unjust reproach of being a pure chance and speculation.

Often for years has a miner been in the peaceful possession of a claim, when suddenly some heretofore undreamed-of claimant appears who must either be bought off or fought off *vi et armis*, either physically or legally, in the one case at the risk of life and in the other of the purse. Instances are not at all uncommon where individuals or corporations have exhausted themselves financially, and their mine as well, in vexatious lawsuits for the sole benefit of attorneys and hungry witnesses. Too often, unfortunately, the rumor of a legal contest summons from all quarters the birds of prey, whose expectant maw, like the ocean, has no limit of capacity to engulf the golden morsels wrung from the baited victims on either side. So terrible has this abuse become that the witnesses cognizant of the true facts in any given case often refuse to give their testimony unless roundly paid therefor, deeming the truth doubtless to be a commodity too valuable to be parted with without a *quid pro quo*. The converse of the proposition follows with such men, as a matter of course, and it is seldom difficult to furnish any missing links of testimony which may be required. In this way the public conscience becomes debauched, the innocent are often unjustly brought into suspicion, and the public is led to believe that bribery and corruption are in all great mining cases the usual arms of legal warfare.

This Augean stable of pollution can never be cleansed until the general law shall have been so modified as to make the records speak for themselves and substantiate facts which now require parol testimony. Hundreds of locations are yearly made by men who, in the quest of fickle fortune, run to every new mining excitement.

The majority, without either means or industry, cumber the ground with locations, which they never really intend to work, and keep off others who are able and willing to develop the resources of the district. This class of speculators, the worst with which any country was ever cursed, is only too numerous in the mining country, retarding its development, locking up its treasures, and preventing the employment of honest laborers, who are willing to give an equivalent for what they receive, instead of supinely waiting for chance to raise them out of the mire.

These evils cry loudly for a remedy. The sober second thought of the people will surely respond to the promptings of their true interest, and overwhelm the demagogues and charlatans who, for their own personal gain, seek to continue the reign of chaos and disorder.

The ultimate foundation of any and all success in mining ventures must rest on an assured title, coupled with a reasonable exemption from wanton assaults at law.

The system heretofore in vogue, instead of repelling, courts attack, and does not in the least protect the weak against the strong.

The powerful corporation, the men of abundant means, can and often do use the very machinery of the law to crush their weaker antagonists. The law should bear equally on all alike, and interpose its strong shield instead of, by its indefiniteness, rendering the title to mining-ground so very uncertain.

To this end I would respectfully suggest the following amendments to the law of 1872:

1st. The insertion of a clear, distinct, and strict clause defining abandonment.

2d. To change the wording respecting work to be done on each claim each year by substituting for $100 the following, viz: A certain number of cubic feet of rock or earth to be excavated in one place, and requiring an affidavit as to work done on the part of the claimant, accompanied by the oaths of two persons other than the claimant, to be filed with the mining recorder of the district[*]—say, for example, the removal in blasting-ground of 200 cubic feet, and in soft picking-ground, the removal, say, of 800 cubic feet. A prospecting shaft, 5 by 4 feet, can be blasted for each foot, in average rock, not far from the surface, for $10 per foot, and for a shaft 10 feet in depth for $100, viz, the amount at present required.

For picking ground or soft, decomposed vein-matter, there might be required say four times this amount.

By making the work itself a patent physical fact, we prevent the vicious necessity of calling in parol testimony for its determination. I have in mind an instance, where, in an actual mining suit, the value of a small excavation was, by the various experts testifying, estimated all the way from $40 to $250.

3d. That provision be made for preliminary or prospect locations. For example, a prospector finds "good indications." Let him file with the recorder a "preliminary notice of location." This should give him, say, ninety days' time within which to determine definitely the course and dip of his vein. During this period of ninety days, no location should be permitted within a radius of 750 feet. At the end of the time allotted, or before, if he sees fit, let him make a "final notice of location," fixing his boundaries as the law now directs; or, failing to do so, let his location lapse.

4th. To make all new mining-claims in the form of a square, 500 feet back of the center-line of outcrop, and 1,000 feet on the side toward the dip, and 1,500 feet in length, with the same rights as now attach under the amended law of 1872.[†]

5th. That all properly worked and not yet patented claims, as well as all "final notices of location" of new claims, be required to be made part of the county records. The careless manner of keeping the mining records, and their usually exposed condition are such as to continually jeopard the title to what may prove of enormous value; and further, the opportunities of tampering with the records themselves are such as most certainly ought to be prevented.

6th. That in already known mining districts no new locations shall be permitted to be made within a square embracing a space of 1,500 by 1,500 feet, within which there exists any patented or properly kept-up claim, (*i. e.*, claim worked as the law now directs,) and that all claims heretofore located, as fast as they lapse and become abandoned, be considered as part and parcel of the claim or claims remaining to such an extent as would be permitted were an original square, of 1,500 by 1,500 feet, located thereon.[‡]

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[*] I do not here agree with Mr. Keyes. The object of the law is attained if operations are continued on the claim to such an extent as to give unmistakable evidence that it has not been abandoned. The requirement of a certain amount of excavation might work great hardship; as, for instance, if the year were spent in constructing a ditch to bring water, or in building a mill to work ores. The present construction of the law is in this point too severe, it seems to me. *Bona-fide* work, to a certain amount, really tending to improve the claim, whether it is drifting, sinking, stoping, cross-tunneling, or road-making, ought to count.—R. W. R.

[†] This would be merely to increase the width of the surface-locations now granted. If it were desirable at all, it would be in order to adopt the square location, pure and simple. The increased width of the inclined location (following the vein in depth) appears to me meaningless.—R. W. R.

[‡] This provision, if literally carried out, would interpose between every two claims a neutral zone of 1,500 feet, which nobody could explore or patent. If a new location could not be made within 1,500 feet of any old one, how could extensions be located?—R. W. R.

The last proposed amendment would in time, obliterate the folly of location piled on top of location, where in reality there is room enough for only one.

I would respectfully propose the above amendments, in the belief that they would tend to make the pursuit of mining more stable. They would, I think, do away with a great majority of the usual litigation, and, by giving security of title, help largely to forward the best interests of our mining domain. The obtaining of a patent, as I argued in 1868, was no safeguard whatever, and mine-owners, after as before, might be compelled to "prove identity," so that the cost of a patent was simply money thrown away. The amendments which I have proposed, or something like them, will make a patent of some real value, and, once obtained, will carry with it a weight commensurate with the dignity of the Government which grants it. So little reliance has been, heretofore, felt in the virtue of an United States patent to a mine, that the best legal talent of the State of Nevada has invariably advised the mine-owners not to make application; and, in one instance within my own knowledge, it happened, as stated to me by one of the best mining lawyers on the Pacific coast, that the chief obstacle to the winning of a certain lawsuit was the very fact that one of the parties thereto had obtained an United States patent. In any pursuit where the rewards of success are as brilliant as they are in mining, the risk must, perforce, be commensurately great. I do not, however, mean to allege that legitimate prospecting outlays bear any comparison with the returns of a rich "strike." Quite the reverse; all miners are ready and willing to take such risks. But when to these there is added the present terrible uncertainty of title, it is enough to discourage all persons, except those who have absolutely nothing to lose, or those who, confident in the length of their purse, can bid defiance to all blackmail, and can even crush out legitimate and poor owners. No system of mining legislation, it is true, can entirely prevent litigation. If it can only hold in check the grasping hand of avarice, on the one hand, and put a stop to wanton blackmail on the other, it will have done all which can be expected. It will be sufficient, if it can be so shaped as to restrain the outrages so frequent in the past, and to give to the *bona-fide* locator a clear and perfect title to a definite and easily determinable portion of mining-ground.

THE RAYMOND & ELY *vs.* HERMES LITIGATION.

Among the more important of the recent mining suits, there is none which better exemplifies the wretched incongruity and utter worthlessness of the rules and customs of miners than the now famous case of the Raymond & Ely Mining Company versus the Hermes Mining Company. Both were San Francisco incorporations; both were in the hands of shrewd, wealthy, and experienced men. The vein in dispute had already yielded millions of dollars, and was supposed to be still capable of producing enormous sums. There was arrayed on either side the very flower of the Pacific mining bar, and it was well understood that the fight would be a contest of giants, intellectual and financial. Experts were summoned from far and near to theorize against one another, and witnesses were hunted up from the inner circles of Mormondom. As usual in such cases, the town of Pioche, where the property lay and the suit was tried, was rocked to its center, and men, openly or covertly, linked themselves with the fortunes of the one or the other party. The jury, as is customary in trials of unusual importance, were locked up in the court-house, from whence they emerged only to take their meals, and then only with a posse of deputy sheriffs, in front, behind, and on either side. Strong armed patrols, in the pay of each party, watched the court-house during the entire night, in order to prevent any approach to the ill-fated twelve, who, for six weary weeks, listened, very patiently, it must be admitted, and perhaps tried to unravel the tangled web of testimony and the specious special pleading of the distinguished advocates.

The money which this suit cost in the way of court-fees, attorneys' fees, witnesses' fees, together with the board, lodging, and traveling expenses of the last-named; also the sums unnecessarily expended in ditching, digging, delving, assaying, &c., would have paid numerous dividends to the stockholders of either company. It has been estimated that the direct and indirect losses and expenditures, prior to and incidental to this suit, amounted, for both parties, to about a half million of dollars. All this money was worse than wasted, and if to this sum we add the shrinkage in value of the stock of the respective companies, we can figure up an actual loss of fully $3,000,000. Worse even, perhaps, than the money-loss, was the malice, hatred, and bitterness stirred up between the partisans of the respective combatants. So serious, indeed, at one time seemed the pitch of excitement to which an overwrought zeal had carried the litigants, that some of the more timid, it may be, expected a general *mêlée* in the very court-house itself; and in a country where very many go fully armed, such a rencounter would have made the floor run streams of blood. The older and cooler heads, however, governed, and the suit was fortunately terminated without any actual blood-letting.

Night and day the excitement continued; night and day the leeches sucked their full at the money-bags, and after the Hermes Company had triumphantly won their case, the Raymond & Ely Company purchased a majority of the stock of the former incorporation, and ended any further appeals to the law by bodily swallowing their antagonist.

Such is the usual course of mining litigation. The rules and customs of miners are the direct cause of such mischievous complications and such wasteful expenditures.

The dwellers in the mining regions would never of their own motion change these regulations: First, because strict and proper rules would take the bread from the mouths of lawyers, experts, and a countless horde of needy and avaricious witnesses; and second, because any attempt at strict definition of boundaries would have too far circumscribed the claims, and if claims were made sufficiently large, there would at once have arisen a howl against so-called monopoly.

The very intent and purpose of the "Miners' Regulations" was to create uncertainty and disorder, to give employment to the law expounders, and to render possible the springing up at any time of some really abandoned claim to blackmail and ruin the miner in good faith.

The whole system needs radical amendment. The law of 1872 is, it is true, a step in the right direction. Let us hope that further amendments will make the law of the future such that the financially feeble mine-owners shall feel secure in the protection of the Government and strong in the intervening might of paramount law.

In order fully to understand the precise nature of the controversy between the Raymond & Ely and the Hermes Mining Companies, it will be necessary to go back to the time of the original discovery of ore in that section of country.

Far down in what was formerly supposed to be the desert portion of the Territory of Utah, now forming a part of Lincoln County, State of Nevada, and early in the year 1864, there camped a party of prospectors from Great Salt Lake City, three hundred miles to the north. These men found upon the ground two persons, to whom croppings of ore had been pointed out by an Indian. They had done some little digging, and had called their claim Panaca, after the native word for metal. The new-comers brought with them a copy of mining regulations such as were then in use in other portions of Utah. The whole party accepted the proposed laws, posted their notices, and set their stakes. Their description of the district, as written, was very ambiguous, and if taken literally would only mean two mathematical lines intersecting one another and inclosing no superficial area. Their chief business seems merely to have been the location of claims; for they located and recorded, at this time and during the ensuing spring, the very modest amount of over 500,000 feet of mining ground. The original party, on their first visit, did several hours' work, and then immediately set out on their return to Salt Lake, at which place the recorder-elect procured a book and inserted the notices of location in form of certificates. These certificates were very loosely written and entirely inadequate to determine the locus of the claims without parol testimony, particularly after the stakes set had fallen down.

We have assumed, thus far, that the claims were made in good faith. From the testimony, however, this point is open to very grave doubt; for one of the witnesses stated that the locations were made merely to keep off the Gentiles, and that they were directed so to do by "counsel," *i. e.*, by the elders and bishops of the Mormon church.

Another witness declared, so little value did he or had he ever placed on the claims, that he had already three or four times given a quit-claim deed for his interest, and was ready to sell again as often as he could get $100.

And further, I would state, not as a matter of testimony in the suit in question, but as forming the basis of another claim, that all or nearly all the title on which the Raymond & Ely Company relied had already been purchased, and was in the hands of a party present at the trial, long before the Raymond & Ely Company, or its grantors, ever had or claimed to have any title in the premises.

To resume: In the early part of June of the following year, viz, 1865, the Salt Lake party returned and did considerable work on the Panaca location. A portion of them agreed to consolidate their segregated claims, and continued the work on a single claim which had not joined the consolidation, but which was afterward either wholly or in part bought in by one of the company.

The laws originally adopted required at least one faithful day's work on each claim during each month, and further provided that when $300 worth of work should have been done on any claim, such claim should be considered "real estate," and could be held without the requirement of any further labor.

On July 15 the few individuals then in the district repealed the sections of the laws requiring work on the claims, and most of them left the district never to return to it. It is stated, however, that one of them remained at the nearest Mormon settlement until the fall of the same year. During the four succeeding years no mining work was done in the district, although many locations purported to have been made, and one of the original party, it is claimed, returned once in 1866 and once in 1867 to show the claims. Even admitting this to be work, everything was still abandoned for over two years, the term of limitation by statute, until the fall of 1869, when a new party of adventurers from San Francisco, Hamilton, and other places, headed by John Ely, all miners in good faith, came in and organized a new district. They formed a code of laws, relocated the various outcrops, went to work in earnest and developed the mines.

In the decision of Judge Beatty, in the subsequent case of the Raymond & Ely *versus* the Kentucky, (printed pamphlet, p. 3,) he states as follows: "It does not appear that any of the original locators did any work under their locations, or were ever in the district after July, 1864, (5?) at least for four or five years." He states further, on p. 6, that presumedly all the Panaca locators had abandoned their claims; concluded, however, that 350 feet might be considered to have escaped the fate of the remainder. Although why, if a portion of the consolidation was good, the remainder was not also good, does not very plainly appear.

At all events, the party of 1869 found the district deserted and the claims abandoned, and there is little doubt that had they found nothing of value the original visitors would have left them severely alone. The new district was christened "Ely," and embraced an area ten miles square.

Under the laws then adopted the district has existed and the mines have been located ever since. By general consent and the almost uniform understanding of the people the early locations are considered as forfeited and abandoned both in law and fact.

The Burke mine, which is the first ever acquired by John Ely, was located under the Ely laws, and was a relocation of one of the abandoned claims.

At the time of the commencement of the litigation between the Raymond & Ely and the Hermes Mining Companies there were no less than eleven locations covering substantially the same ground. Some were 1864 locations, others 1869 locations, and others still later. None had, however, struck the ore-channel except, first, the Raymond & Ely Company; second, the Hermes; and, third, the Pioche Phœnix. The pay-ore was found only in the quartzite, superimposed upon which was a thick stratum of magnesian shale, and above this again a heavy mass of mountain limestone. The shale thickened toward the west, and consequently the farther west a shaft might be sunk, the deeper would it be necessary to go before reaching the ore-bearing quartzite.

Of these eleven different locations two had commenced work some distance north of the ore-channel. After sinking to a considerable depth, and drifting to the south, the one struck in under the Hermes workings, and the other party, coming to the conclusion that a direct line to the goal was the shortest, removed their hoisting-works bodily to the south, and came at last, as was to be expected, upon the ore-body. The coolness of these proceedings was more than refreshing. Here were locations made in barren shale, off the line of the vein, which, as soon as its true course was known, unblushingly ran for it, without any regard to prior discovery and actually prior possession. These two companies were not parties to the litigation, but it was impossible to say when, falling into strong hands, they might see fit to use their color of title to harass and annoy whichever of the two contestants might ultimately triumph. The locations on and near the ground in dispute were thick as leaves in Valombrosa, and I merely mention the fact to show the ludicrously vicious state of the mining law which should for a moment countenance such an iniquitous anomaly. In all justice and common sense there should have been at most but two locations, the one north and south, the other east and west.

Prior to the month of May, 1871, the Raymond & Ely Company had only worked the mines known as the Burke and Creole. These were separated from what was afterward called the Panaca mine, by at least 1,000 feet. The company had, up to this time, paid only two or three dividends of $1 each per share, *i. e.*, a monthly disbursement of $30,000. C. W. Lightner was the superintendent of the company, and D. W. Perley its chief legal adviser.

Finding now that the pay-ore was about exhausted in the Burke and Creole, Lightner of his own motion commenced what is now known as the Lightner shaft, hoping to strike something which should enable the company to keep up its dividends. At this time the Raymond & Ely claimed 600 feet of one of the old 1864 locations, called the Mammoth, and also about the same amount of the Panaca; the former was an east and west, the latter a north and south location. When Lightner commenced his shaft, all of the Mammoth and all of the Panaca, then claimed by the Raymond & Ely Company, were covered by new locations, under the Ely laws, and the ground was in the actual possession of adverse claimants under these laws.

Lightner entered and took possession under color of the Mammoth title, without any reference to the Panaca; and this was the first actual possession the company ever had. The shaft was sunk very rapidly through the soft, decomposed shale, and in June, 1871, the ledge was struck at a depth of about 100 feet. This was the beginning of the wonderful "Bonanza," from which such enormous profits were subsequently realized. Not knowing positively what ledge had been struck, Perley advised Lightner to locate it for the company. This Lightner refused to do, on the ground that such a proceeding might endanger the old location. Perley then informed Lightner that he wished to locate for himself an extension of the ledge struck in the Lightner shaft, and, in order not to intrude upon the company's ground, requested Lightner to measure off the ground claimed by them. This Lightner did and fixed the western limit of his company's claim 600 feet west of the old Mammoth starting-point. Perley then, in presence of both the superintendent and mining foreman of the Raymond & Ely, built his monument and placed upon it the Hermes notice of location, claiming 1,000 feet westerly from that point. This location was made August 1, 1871. Work was immediately commenced, and continuously prosecuted until January, 1873, without any claim ever having been made either by Mr. Raymond personally, or by the Raymond & Ely Company. On the 9th of September, 1871, Lightner took Mr. Raymond, who was the largest owner in the Raymond & Ely Company, on the ground, showed him the Hermes shaft, and pointed out the ground claimed by the Hermes Company. Raymond, at that time, made no claim to the ground and advised that the Hermes go on with their work. In September, 1871, viz, some six weeks after the Hermes location, Raymond bought for himself, at Salt Lake, 600 feet more of the old 1864 Panaca extensions, with a view, doubtless, of claiming the ground located by the Hermes Company. He did nothing with them, however, until about January, 1873, when he conveyed them to the Raymond & Ely Company, who then commenced the action against the Hermes Company.

During all this long period of time, viz, from August, 1871, until January, 1873, the Hermes had steadily worked its ground and had sunk its shaft 600 feet, and had expended in hoisting-works and other improvements over $100,000. The Raymond & Ely Company, during all this time, had full knowledge of the Hermes claim.

Before Raymond conveyed his Panaca extensions to the Raymond & Ely, the company had been sued by C. F. McDermott, of San Francisco, on the same identical extensions. Perley went to San Francisco, defended the action, and McDermott was defeated. Subsequently Raymond bought out McDermott and conveyed the title, thus acquired, to the company. The case was tried before a jury in Pioche in April, 1873, the Raymond & Ely Company being plaintiff, and the Hermes Company defendant.

The chief points made by the defendant before the court and jury were as follows:

1st. That the Raymond & Ely Company entered into possession of the ground under the Mammoth title, and not the Panaca, and were entitled only to 600 linear feet on the vein.

2d. That the Hermes location commenced at the west end of that 600 feet and in no way interfered with them.

3d. That the Panaca was a north and south location, and was not made on the ledge in question but, on a wholly separate ledge.

4th. That the Panaca location did not connect with the ledge struck in the Lightner shaft.

5th. That the Panaca notice of location was never made in good faith; that it was not properly recorded, and that it was utterly void for uncertainty.

6th. That if, by any possibility, the Panaca location could be considered as covering any part of the Hermes ground, it was forfeited and abandoned by the original locators long before its conveyance to the Raymond & Ely Company.

7th. That the extensions, bought by Raymond six weeks after the location of the Hermes, were fraudulent, void, and abandoned; and even if valid were, by the stakes set, out of the line of the Hermes, on segregated ground far to the south.

8th. That the Hermes was located on vacant public land of the United States, was held and worked in good faith with the full knowledge of the Raymond & Ely Company for the space of over one year and a half, before the latter made any claim to it.

These issues were decided by the jury in favor of the defendant (the Hermes Company,[*]) and thereupon, as has been remarked, the two interests were compromised. Such is a brief recital of the main points of a controversy now past. I hope it may serve to call attention to the crudities of the mining customs and the looseness of the mining law.

There are other defects in the mining law than those alluded to by Mr. Keyes, which need careful amendment. One of these is the provision which prevents foreign owners from obtaining patents. It is founded in bad policy, and serves no purpose that is not injurious to American interests. Since it does not prevent the purchase by foreigners of patents once obtained by citizens, the only effect of it is to make mining-claims owned by poor Americans unsalable to foreign capitalists.

Another point which ought to be changed is the nature of the work required to hold the possessory title. Work in a tunnel or vertical shaft, intended to develop a lode, should count as work done on the claim itself; and the same is true, in my view, of surface-improvements, such as roads and buildings, provided that the same work is not reckoned twice over, and thus applied to hold different lodes. Moreover, when several lodes are held in common, and are so situated that they may be patented in common or worked in common, it seems to me that the work required to hold them might well be allowed to be done wholly on one. The contrary construction frequently forces the waste of money in scattered excavations, which will afterward be useless. The law was not intended to force the doing of useless work.

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[*] Judge Beatty held that a connection was proved before him between the Panaca and the Lightner vein. Mr. Keyes did not think this the case; but I have struck out his argument on the point as not clear to a reader who has neither a personal knowledge of the ground nor the means of studying it from detailed surveys and maps.—R. W. R.

The ambiguity and undue extension of the rights given to tunnel-locations, together with the fatal omission to provide for the permanent ownership of tunnels under patents, also require attention. I do not dwell on these points, because I presume they will be dealt with by Congress before the publication of this report. The operation of the law of 1872 has been delayed until June 10, 1874,* so far as older locations are concerned. I trust there will be no extension of this time. There may be individual hardships; but there is public benefit in the universal execution of the law.

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* Since again extended to January 1, 1875.—R. W. R.

CHAPTER XXIV.

MISCELLANEOUS STATISTICS.

According to my usual practice I shall give the estimates of the bullion product, to which I have been led by my observations and inquiries, and by the reports furnished me through officials and correspondents; and with these, for the purposes of comparison, the statistics obtained by the express company and those published by the press of San Francisco. Mr. Valentine's statement, which will be found below, includes British Columbia and Mexico, as mine does not, and omits Wyoming, New Mexico, and a large part of the product of Arizona. We only differ seriously as to Montana and Utah, one of which he credits with more, and the other with less, than I do. The grounds of my estimates for these Territories will be found in the respective chapters referring to them. It is only fair to repeat here what I have had occasion to say before, that, Mr. Valentine's estimate being made very soon after the end of the year, I have the advantage of several months' delay in obtaining details for items which he can only approximate. The system and accuracy which he maintains in the vast express business, of which he has the charge, render him an authority from which I always differ with hesitation and regret.

According to the most careful determination I have been able to make, the bullion product of 1872, compared with that of previous years, was as follows:

States and Territories.	1869.	1870.	1871.	1872.	1873.
Arizona	$1,000,000	$800,000	$800,000	$625,000	$500,000
California	22,500,000	25,000,000	20,000,000	19,049,008	18,025,722
Colorado	*4,000,000	3,675,000	4,663,000	4,661,465	4,020,263
Idaho	7,000,000	6,000,000	5,000,000	2,695,870	2,500,000
Montana	9,000,000	9,100,000	8,050,000	6,068,339	5,178,047
Nevada	14,000,000	16,000,000	22,500,000	25,548,801	35,254,507
New Mexico	500,000	500,000	500,000	500,000	500,000
Oregon and Washington	3,000,000	3,000,000	2,500,000	2,000,000	1,565,784
Wyoming	....	100,000	100,000	100,000	50,000
Utah	....	1,300,000	2,300,000	2,445,284	3,778,200
Other sources	†500,000	525,000	250,000	250,000	250,000
Total	61,500,000	66,000,000	66,663,000	63,943,857	71,642,393

* Including Wyoming. † Including Utah.

EXPRESS STATISTICS.

[From the Alta California.]

W., F. & Co.'s Express,
General Superintendent's Office,
San Francisco, December 31, 1873.

We hand you herewith a copy of our annual statement of precious metals produced in States and Territories west of the Missouri River—including British Columbia—during 1873. A comparison with the statement for 1872, published in the Alta of January 3, will show that the aggregate exceeds that of 1872 more than $10,000,000. Arizona, California, British Columbia, Oregon, Washington, Idaho, and Montana decrease. Nevada, Utah, and Colorado increase. The increase in Nevada alone is nearly $10,000,000, the total product of which about equals all the others. As stated in our report for 1872, we only touch the borders of Arizona; therefore the figures given do not furnish a correct basis for estimating the product of that Territory, but it is inappreciable as compared with the others. Mexico is represented in silver only, and the amount named will not give a correct idea of the product of the Pacific or West Mexican coast, as the Pacific Mail Steamship Company carry independent of Wells, Fargo & Co., in addition to which large amounts are conveyed by British war vessels to Panama or San Francisco, of which we make no record.

The combined product of all shows—for 1872, $62,236,913; for 1873, $72,258,693—undoubtedly the largest yield for one year in the history of the Pacific coast.

Yours truly,

JOHN J. VALENTINE,
General Superintendent.

Statement of precious metals produced in States and Territories west of Missouri River during 1873.

States and Territories.	Gold dust and bullion by express.	Gold dust and bullion by other conveyances.	Silver bullion by express.	Ores and base bullion by freight.	Total.
California	$15,709,956	$1,570,995	$264,771	$480,000	$18,025,722
Nevada	219,141	43,828	30,183,921	4,807,617	35,254,507
Oregon	1,146,991	229,398	....	....	1,376,389
Washington	171,951	34,390	3,054	....	209,395
Idaho	1,171,131	234,226	938,297	....	2,343,654
Montana	3,241,238	648,247	3,325	....	3,892,810
Utah	112,003	22,400	1,210,434	3,561,500	4,906,337
Arizona	37,074	7,415	3,289	....	47,778
Colorado	1,856,639	....	839,862	1,386,767	4,083,268
Mexico	....	....	868,798	....	868,798
British Columbia	1,041,696	208,339	....	....	1,250,035
Total	....	....	....	....	72,258,693

Treasure receipts and exports at San Francisco.

TREASURE EXPORTS.

Our treasure exports for 1873 and the past two years have been as follows, exclusive of shipments through United States mail:

Destination.	1871.	1872.	1873.
To New York	$8,057,279 33	$4,055,565 46	$14,597,895 76
To England	3,184,841 74	2,262,302 25	667,109 81
To China	3,442,908 72	7,476,862 72	6,335,353 50
To Japan	738,412 67	10,212,949 63	2,206,157 12
To Panama	115,146 49	56,679 82	....
To other countries	1,714,458 16	5,266,075 76	908,609 49
Total	17,253,347 11	29,330,435 64	24,715,125 68

The comparative description of our exports of treasure by the above table was as follows:

Description of export.	1871.	1872.	1873.
Gold bars	$3,566,535	$11,910,565	$2,828,692
Silver bars	8,663,944	7,913,391	8,457,739
Gold coin	3,028,100	7,888,620	9,076,173
Mexican dollars	1,872,184	1,427,441	3,779,063
Gold dust	37,514	37,007	77,645
Silver coin	....	....	106,529
Trade dollars	85,070	153,412	389,234
Total	17,253,347	29,330,436	24,715,125

COMBINED EXPORTS.

The combined exports, treasure and merchandise, exclusive of overland railroad, during the past twelve months, as compared with the same time in 1871 and 1872, were as follows:

Combined exports.	1871.	1872.	1873
Treasure	$17,253,347	$29,330,436	$24,715,126
Merchandise	13,951,149	23,793,530	31,160,208
Total	31,204,496	53,123,966	55,875,334

TREASURE PRODUCT, IMPORTS, ETC.

The receipts of treasure from all sources, through Wells, Fargo & Co.'s Express, during the past twelve months, as compared with the same period in 1872, have been as follows:

	1872.	1873.
From northern and southern mines	$28,000,270	$26,675,721
Coastwise, north and south	2,477,978	2,079,958
Imports, foreign	8,060,412	5,539,147
Total	38,538,660	34,294,826

MOVEMENT OF COIN IN THE INTERIOR.

The following has been the circulation of coin through Wells, Fargo & Co.'s Express during the year 1873:

	To interior.	From interior and coastwise.
January	$1,491,140	$692,771
February	1,102,813	552,284
March	965,742	671,719
April	1,006,845	614,546
May	858,104	537,052
June	993,517	525,657
July	1,061,480	669,499
August	1,493,211	562,593
September	2,231,864	577,747
October	1,876,747	1,074,595
November	1,850,907	901,709
December	1,495,863	704,351
In 1873	16,428,233	8,084,523
In 1872	18,014,203	7,996,007
Decrease	1,585,970	....
Increase	....	88,516

RECEIPTS OF TREASURE.

The following table comprises the receipts of treasure in this city, through Wells, Fargo & Co.'s Express, during the year 1873:

From the northern and southern mines.

1873.	Silver bullion.	Gold dust.	Coin.	Total.
January	$295,261	$629,305	$555,535	$1,480,101
February	291,094	487,696	472,115	1,250,395
March	246,504	613,282	451,471	1,311,257
April	1,293,928	733,351	461,407	2,488,686
May	1,772,896	776,709	417,922	2,967,527
June	867,065	858,929	404,114	2,130,108
July	1,117,382	1,011,764	550,275	2,686,421
August	1,293,292	963,789	451,252	2,708,333
September	1,606,611	628,534	501,114	2,736,259
October	1,282,190	508,647	954,480	2,745,317
November	864,983	614,234	802,479	2,281,696
December	838,114	464,618	604,979	1,907,711
Total	11,749,320	8,290,258	6,636,143	26,675,721
Total 1872	6,386,794	14,843,835	6,769,641	28,000,270
Total 1871	14,609,809	13,872,648	7,125,928	35,608,385
Trtal 1870	14,152,984	17,762,131	6,487,037	38,402,152
Total 1869	(*)	(*)	11,572,504	44,045,445

* Not separated.

From the northern coast.

1873.	Silver bullion.	Gold dust.	Coin.	Total.
January	....	$123,256	$61,537	$184,793
February	....	44,579	40,457	85,036
March	....	33,783	172,197	205,980
April	$4,200	49,134	114,517	167,851
May	....	64,663	62,860	127,523
June	....	97,494	82,114	179,608
July	....	137,405	73,653	211,058
August	....	231,399	44,826	276,225
September	....	184,968	40,797	225,765
October	....	238,521	76,111	314,632
November	....	149,055	57,770	206,825
December	....	87,181	51,538	138,719
Total	4,200	1,441,438	878,377	2,324,015
Total 1872	....	2,305,414	661,889	2,967,303
Total 1871	9,785	2,552,668	708,096	3,270,549
Total 1870	....	3,380,566	532,901	3,913,467
Total 1869	(*)	(*)	300,397	2,958,436

* Not separated.

From the southern coast.

1873.	Silver bullion.	Gold dust.	Coin.	Total.
January	....	$14,996	$75,609	$90,605
February	....	3,650	39,712	43,362
March	$1,200	6,850	48,051	56,101
April	....	12,919	38,622	51,541
May	....	14,098	56,270	70,368
June	500	16,030	39,429	55,959
July	....	22,209	36,571	58,780
August	500	11,350	66,515	78,365
September	605	16,965	35,836	53,516
October	....	22,648	44,014	66,662
November	793	22,408	41,460	64,661
December	....	16,394	47,834	64,228
Total	3,698	180,537	570,013	754,248
Total 1872	3,884	274,249	564,477	842,610
Total 1871	5,750	347,627	551,413	904,790
Total 1870	....	399,888	844,548	1,244,436
Total 1869	(*)	(*)	227,000	2,282,571

* Not separated.

Currency movement.

The annexed table exhibits the interior and coastwise receipts, (Wells, Fargo & Co.,) imports, foreign, and exports for the years 1871, 1872, and 1873:

	1871.	1872.	1873.
Interior receipts	$38,853,816	$30,478,248	$28,755,679
Imports, foreign	4,108,724	8,060,412	5,539,147
Total	42,962,540	38,538,660	34,294,826
Exports	17,253,347	29,330,436	24,715,126
Currency movement	25,709,193	9,208,224	9,579,700

MINT STATISTICS.

The coinage at the branch mint in this city for 1873 compares with that in 1870, 1871, and 1872, as follows:

	1870.	1871.	1872.	1873.
January	$1,620,000	$1,570,000	$240,750	$900,000
February	985,000	1,171,725	1,210,000	1,219,400
March	2,155,000	965,000	1,127,750	1,140,000
April	1,330,000	1,800,000	1,420,000	1,282,000
May	2,083,000	2,178,050	2,020,000	2,772,000
June	1,846,000	881,000	666,000	652,000
July	120,000	2,760,000	2,245,000	3,022,000
August	2,370,000	1,900,000	730,000	2,131,000
September	2,030,000	2,210,000	1,264,500	2,264,500
October	1,875,000	1,669,000	1,895,000	2,658,000
November	1,965,000	1,684,000	1,525,000	254,500
December	1,676,000	1,218,000	1,436,600	3,720,000
Total	20,355,000	20,026,775	16,389,600	22,075,400

The description of coinage for the twelve months of 1872 and 1873 was as follows:

	1872.	1873.
Double-eagles	$15,600,000	$20,812,000
Eagles	173,000	120,000
Half-eagles	202,000	155,000
Quarter-eagles	25,000	67,500
Half-dollars	290,000	116,500
Quarter-dollars	26,250	39,000
Dimes	19,000	45,500
Half-dimes	36,350	16,200
Silver dollars	9,000	700
Trade dollars	....	703,000
Total	16,380,600	22,075,400

Tabular statement of imports, exports, and re-exports of gold and silver coin and bullion from 1867 *to* 1873, *inclusive.*

[Compiled from the monthly reports of the Bureau of Statistics.]

IMPORTS.

Year ending December 31.	Bullion.			Coin.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
1867	$1,345,259	$61,074	$1,406,333	$5,082,915	$4,619,100	$9,702,015
1868	1,174,570	115,520	1,290,090	7,541,239	4,863,609	12,404,848
1869	751,821	97,829	849,650	15,829,763	8,289,114	24,118,877
1870	833,689	127,928	961,617	9,596,872	15,014,874	24,611,746
1871	1,335,196	147,682	1,482,878	4,506,752	10,779,785	15,286,537
1872	1,905,289	450,103	2,355,392	9,208,001	9,618,611	18,826,612
1873	1,439,953	608,348	2,048,301	19,097,301	8,603,837	27,701,138
Total for seven years	8,785,777	1,608,484	10,394,261	70,862,843	61,788,930	132,651,773

EXPORTS.

Year ending December 31.	Bullion.			Coin.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
1867	$19,192,299	$15,503,527	$34,695,826	$30,839,898	$1,919,368	$32,759,266
1868	17,402,625	13,987,210	31,389,835	38,328,530	2,012,716	40,341,246
1869	13,681,984	12,748,315	26,430,299	12,938,834	1,668,304	14,607,138
1870	15,599,880	13,171,419	28,771,299	33,101,931	4,224,087	37,326,018
1871	6,068,123	20,165,739	26,233,912	37,293,426	1,904,004	39,197,430
1872	12,754,257	23,110,449	35,864,706	55,178,229	1,252,301	56,430,530
1873	2,552,361	29,221,993	31,774,354	22,180,982	2,299,160	24,480,142
Total for seven years	87,251,579	127,908,652	215,160,231	229,870,830	15,279,940	245,150,770

RE-EXPORTS.

Year ending December 31.	Bullion.			Coin.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
1867	$60,641	$251,924	$312,565	$2,836,698	$4,989,243	$7,825,941
1868	50,871	635,339	686,210	4,150,810	4,591,483	8,742,293
1869	16,142	15,206	31,348	7,934,976	8,352,250	16,287,226
1870	25,778	2,682	28,460	4,689,722	10,136,226	14,825,948
1871	4,780	91,342	96,122	1,549,506	10,363,410	11,913,006
1872	....	89,975	89,975	705,639	7,506,074	8,301,713
1873	....	93,511	93,511	753,775	6,461,543	7,215,318
Total for seven years	158,212	1,179,979	1,338,191	22,621,216	52,490,229	75,111,445

RECAPITULATION.

For seven years, from 1867 *to* 1873, *inclusive.*

	Gold.		Silver.	
	Bullion.	Coin.	Bullion.	Coin.
Domestic exports	$87,251,579	$229,870,830	$127,908,652	$15,279,940
Re-exports	158,212	22,621,216	1,179,979	52,490,229
Total	87,409,791	252,492,046	129,088,631	67,770,169
Less imports	8,785,777	70,862,843	1,608,484	61,788,930
Net exports	78,624,014	181,629,203	127,480,147	5,981,239

Grand total of gold and silver exported in excess of imports during seven years.........$393,714,603

The following elaborate statements of the bullion receipts and dividends of leading mines for the years 1870 to 1873, inclusive, are taken from Mr. Wheeler's San Francisco Weekly Stock Report and California Street Journal, than which there is no better authority. Only those mines are included the stocks of which are dealt in at the San Francisco board—a list which includes the leading American joint-stock-companies of the Pacific slope, but not the English companies operating there, nor the enterprises conducted by private parties. For information concerning these the reader is referred to the preceding pages of this report.

Bullion receipts for 1870.

Companies.	January.	February	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Belcher	$34,106	$50,789	$14,028	$31,698	$27,316	$36,048							$194,585
Caledonia	2,078	4,442	7,276										13,796
Crown Point		22,046	33,440	19,680		26,730	$20,188	$16,484	$23,215	$20,394	$26,673	$32,357	241,207
Chollar	115,263	91,545	113,189	130,361	146,984	215,548	261,277	249,553	264,551	275,716	258,297	505,654	2,627,938
Gould & Curry	18,239	33,384	50,213	48,725	94,045	41,027	36,586	75,041	109,022	65,252	60,099	44,553	676,186
Gold Hill Quartz	3,808				3,682	560	482		2,153	1,825	2,076	2,533	17,719
Hale & Norcross	188,334	145,203	107,057	125,849	164,830	187,845	200,863	149,328	125,969	116,766	115,540	80,679	1,708,263
Imperial	13,675	12,601	11,932	12,975	10,104	7,478	10,390	11,192	18,632	26,357	18,028	14,895	168,259
Kentuck	31,207	29,301	31,790	21,226	18,929	13,740	9,466	8,083					163,742
Overman	49,299	57,613	72,000		51,000	18,700	19,200	16,600	21,800	37,400	48,400	41,900	433,912
Savage	25,650	7,035	23,030	6,300				32,400	32,650	45,330	47,325	71,400	421,090
Sierra Nevada	12,327	12,092	15,472	15,067	15,798	16,342	12,820	28,055	23,939	21,003	24,879	24,981	223,374
Segregated Belcher					29,574	26,170	10,691			8,140			73,975
CALIFORNIA DISTRICT.													
Amador	63,884	58,692	56,127	31,590					19,080	20,232	25,738	26,127	301,470
Eureka													683,328
ELY DISTRICT.													
Meadow Valley												151,675	151,675
IDAHO DISTRICT.													
Golden Chariot	25,138	35,055	21,846		18,566	18,566	18,566	50,606	64,616	78,576	76,187	76,277	483,999
Ida Elmore													238,532
Total	583,008	559,798	557,790	444,071	560,828	608,754	599,929	637,342	705,627	716,990	703,242	1,073,031	8,822,450

Dividends for 1870.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
CALIFORNIA DISTRICT.													
Amador	$37,000	$37,000	$37,000	$37,000									$148,000
Eureka	30,000	30,000	30,000	30,000	$30,000	$60,000	$30,000	$30,000	$40,000	$40,000	$40,000	$40,000	430,000
Golden Rule			1,500										1,500
WASHOE.													
Chollar	28,000	28,000		28,000	28,000	28,000	28,000	56,000	70,000	84,000	112,000	140,000	630,000
Gould & Curry										48,000			48,000
Hale & Norcross	48,000	48,000	48,000	48,000	60,000	60,000	40,000	40,000	40,000	40,000	40,000	40,000	552,000
Kentuck	20,000	10,000											30,000
Sierra Nevada										7,500	7,500	15,000	30,000

IDAHO DISTRICT.													
Golden Chariot									20, 000	25, 000	30, 000		75, 000
Ida Elmore	10, 000	10, 000											20, 000
WHITE PINE DISTRICT.													
Original Hidden Treasure						31, 999							31, 999
Total	173, 000	163, 000	116, 500	143, 000	118, 000	179, 999	98, 000	126, 000	170, 000	244, 500	229, 500	235, 000	1, 996, 499

Assessments for 1870.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Alpha							$6, 000						$6, 000
American		$48, 000				$34, 800							82, 000
Aurora Consolidated					$64, 000		80, 000						144, 000
Belcher						41, 600			$20, 800			$10, 400	72, 800
Bullion		10, 000				12, 500				$7, 500		7, 500	37, 500
Consolidated Chloride												50, 000	50, 000
Consolidated Virginia	$23, 200						11, 600		11, 600			17, 400	63, 800
Confidence					15, 600								15, 600
Crown Point	90, 000							$36, 000		42, 000			168, 000
Dancy		8, 000					8, 000						16, 000
Empire Mill	40, 000			$12, 000				7, 200		4, 800			64, 000
Exchequer	24, 000												24, 000
Gold Hill Quartz					10, 000				9, 000				19, 000
Gould & Curry	72, 000						60, 000						132, 000
Hidden Treasure Consolidated			$6, 000										6, 000
Ida Elmore									50, 000				50, 000
Imperial			40, 000		20, 000						$40, 000		100, 000
Julia					7, 500		7, 500			5, 000			20, 000
Justice			36, 000										36, 000
Kentuck								10, 000					10, 000
Lady Bryan	45, 000		36, 000			36, 000							117, 000
Mammoth	7, 200									3, 600			10, 800
Occidental				60, 000			50, 000			15, 000			125, 000
Original Hidden Treasure								42, 666					42, 666
Ophir	33, 600		50, 400		84, 000				50, 400		33, 600		252, 000
Overman												32, 000	32, 000
Rising Star				6, 000									6, 000
Savage		160, 000			120, 000								280, 000
Segregated Belcher			12, 800					9, 600			6, 400		28, 800
Silver Wave					60, 000								60, 000
Yellow Jacket			168, 000										168, 000
Total	335, 000	226, 000	350, 200	78, 000	381, 100	124, 900	223, 100	105, 466	141, 800	77, 900	80, 000	117, 300	2, 240, 766

Bullion receipts for 1871.

Companies.	January.	February	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Belcher								$50,925	$101,103	$313,640	$345,419	$328,037	$1,139,124
Buckeye			$5,523	$4,505	$6,646		$3,000	6,149				3,064	28,977
Choller Potosi	$276,606	$241,967	301,722	273,160	319,966	$181,502	151,129	66,128	69,924	73,149	76,649	40,723	2,072,611
Crown Point	31,864	2,308	71,741	180,507	273,767	264,847	199,376	161,291	165,898	141,695	234,797	223,129	1,951,220
Caledonia					37,979	33,651	16,568	17,211	22,276	21,001	26,505	8,295	183,486
Gould & Curry	18,018		17,931							12,075			48,024
Gold Hill Quartz	6,448	7,159	9,010	3,290	7,867	1,021	1,023	1,975		1,453	1,474	2,868	43,588
Hale & Norcross	112,897	121,935	122,049	102,202	89,162	73,061	38,546	46,496	59,294	72,775	60,009	42,935	941,441
Imperial	10,758	10,104											20,862
Kentuck					15,509	21,650	20,604	21,153	18,442	20,432	25,312	8,753	151,947
Overman													35,439
Savage	130,450	95,600	98,090	104,860	91,755	97,035	89,965	83,700	63,420	60,980	74,125	56,132	1,073,112
Sierra Nevada	13,175	6,148	10,154	8,182	14,452	14,332	19,760	16,315	16,170	9,713	10,158	8,491	147,070
Segregated Belcher			6,503	12,880	18,391	20,748				11,389			69,911
Succor	4,810	4,560	7,082	4,166	7,802	5,112	11,699	24,044	22,418	18,238	13,595	10,325	134,051
ELY DISTRICT.													
Meadow Valley	159,015	125,046	130,758	82,746	119,328	157,498	193,665	173,229	150,643	182,335	156,423	123,022	1,753,708
Pioche						24,889	38,549	52,125	32,000		56,010		203,573
Raymond & Ely	13,146	52,388	62,585	26,126	62,147	63,525	61,163	108,285	175,505	250,764	261,592	167,123	1,310,349
CALIFORNIA DISTRICT.													
Amador	26,049	33,410	27,855	22,242	8,751	13,105	2,666		11,859	6,781	12,504	30,051	195,363
Eureka	89,101	58,274	43,648	47,048	35,421	45,122	29,410	18,667	21,980	8,533	31,559	34,698	463,461
Yule Gravel			200	1,074	2,593	7,024	6,967	7,157	6,580	7,147	6,638		45,380
IDAHO DISTRICT.													
Golden Chariot							45,133	32,922	24,690			11,552	114,319
EUREKA DISTRICT.													
Eureka Consolidated													1,377,865
Jackson													68,286
Phenix								9,561	2,367	7,513	15,998		35,439
Total	901,337	764,919	914,851	873,138	1,111,619	1,034,131	929,458	897,333	964,509	1,239,606	1,406,857	1,099,198	13,598,546

Dividends for 1871.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Crown Point					$120,000	$120,000	$120,000	$120,000	$120,000				$600,000
Chollar Potosi	$280,000	$280,000	$280,000	$140,000	140,000	56,000	56,000	28,000	28,000	$28,000	$28,000	$28,000	1,372,000
Hale & Norcross	40,000	40,000	40,000	40,000									160,000
Sierra Nevada	15,000												15,000
Succor										10,000			10,000
Yellow Jacket	48,000	48,000	60,000	60,000	60,000	60,000	60,000	60,000					456,000
ELY DISTRICT.													
Meadow Valley	60,000											60,000	120,000
Pioche									20,000				20,000
Raymond & Ely			30,000	30,000		30,000	30,000	30,000	45,000	120,000	150,000	150,000	615,000
CALIFORNIA DISTRICT.													
Amador				14,800	7,400								22,200
Eureka	40,000	40,000	40,000	40,000	40,000	40,000	20,000						260,000
IDAHO DISTRICT.													
Golden Chariot	60,000	70,000	70,000		70,000								270,000
EUREKA DISTRICT.													
Eureka Consolidated	50,000	37,500								50,000			137,500
Total	593,000	515,500	520,000	324,800	437,400	306,000	286,000	233,000	213,000	208,000	178,000	238,000	4,057,700

Assessments for 1871.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Alpha			$6,000										$6,000
Bullion		$15,000			$15,000			$10,000				$20,000	60,000
Belcher		10,400		$41,600									52,000
Confidence		4,680											4,680
Consolidated Virginia		11,600			11,600			17,400			$17,400		58,000
Daney	$12,000		16,000			$20,000			$16,000		8,000		72,000
Empire Mill				24,000				14,400					38,400
Gould & Curry		60,000			72,000				72,000				204,000
Hale & Norcross									20,000		30,000		50,000

Assessments for 1871—Continued.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE—Continued.													
Imperial		$40,000	$60,000		$40,000				$40,000				$180,000
Julia			10,000		5,000			$5,000					20,000
Kentuck	$20,000				20,000								40,000
Overman		32,000		$64,000			$25,600		51,200		$25,600		198,400
Ophir	33,600		50,400		50,400		84,000						218,400
Occidental		50,000											50,000
Segregated Belcher	12,800		19,200				32,000						64,000
Succor					22,200								22,200
Sierra Nevada				37,500									37,500
ELY DISTRICT.													
Lillian Hall											7,500		7,500
Meadow Valley West Extension							6,000						6,000
Pioche												$20,000	20,000
Washington & Creole											15,000		15,000
CALIFORNIA DISTRICT.													
Bellevue											8,000		8,000
St. Patrick										$25,000			25,000
IDAHO DISTRICT.													
Golden Chariot									20,000		30,000		50,000
Ida Elmore	25,000									20,000		30,000	75,000
Mahogany			12,000			$12,000					12,000		36,000
WHITE PINE DISTRICT.													
General Lee				2,000								2,000	4,000
Mammoth	3,600							3,600				3,600	10,800
Noonday	4,000			4,000			4,000			4,000			16,000
Original Hidden Treasure	21,333						42,666				31,999		95,998
Silver Wave									20,000			60,000	80,000
Virginia							5,333						5,333
EUREKA DISTRICT.													
Jackson								12,500				12,500	25,000
Phenix				12,500									12,500
Totals	132,333	223,680	173,600	185,600	236,200	32,000	199,599	62,900	239,200	49,000	185,499	148,100	1,867,711

Bullion receipts for 1872.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Belcher	$426, 128	$290, 397	$354, 681	$365, 915	$429, 349	$407, 772	$321, 422	$251, 791	$442, 201	$366, 327	$534, 395	$604, 137	$4, 794, 515
Buckeye		6, 132	6, 742	5, 442	11, 456	4, 480	9, 902	9, 579	4, 939	2, 067	3, 921	3, 240	67, 990
Crown Point	231, 644	167, 658	630, 848	808, 681	536, 072	414, 993	385, 656	296, 511	359, 403	253, 239	242, 253	271, 987	4, 598, 850
Chollar Potosi	15, 846	54, 851	69, 146	77, 615	64, 073	78, 230	80, 273	52, 202	55, 464	70, 131	62, 103	51, 996	731, 930
Hale & Norcross	28, 351	66, 327	42, 347	72, 135	51, 793	29, 358	38, 257	53, 868	55, 018	53, 253	54, 047	72, 854	617, 608
Kentuck		11, 839	13, 441	14, 559	16, 135	19, 400	17, 237	20, 543	14, 502	8, 822	4, 011		140, 549
Savage	17, 775	67, 070	145, 970	23, 430	99, 992	76, 535	64, 466	61, 810	75, 050	58, 842	49, 780	50, 218	790, 818
Sierra Nevada	11, 421	8, 927	11, 530	13, 675	9, 384	8, 048	9, 945	8, 936	12, 837	11, 967	9, 507	10, 959	127, 426
Woodville													27, 926
ELY DISTRICT.													
Bowery													36, 485
Huhn & Hunt													13, 129
Meadow Valley	141, 911	133, 122	153, 406	111, 033	120, 290	95, 667	87, 290	90, 372	130, 888	115, 774	111, 113	82, 671	1, 303, 537
Pioche	29, 639				58, 539	53, 604	39, 978	25, 416		9, 791	13, 758	1, 592	232, 417
Raymond & Ely	179, 785	198, 254	310, 978	317, 710	335, 910	328, 795	344, 696	372, 177	335, 570	344, 411	303, 253	321, 189	3, 693, 728
Washington & Creole													84, 500
IDAHO DISTRICT.													
Golden Chariot		11, 179								4, 519	13, 007	10, 488	39, 193
CALIFORNIA DISTRICT.													
Amador	40, 076	42, 327	45, 450	57, 374	62, 110	29, 973							277, 310
Cederberg													52, 515
Eureka	15, 570	8, 690	7, 003	18, 846	16, 543	14, 626	22, 662	10, 034	23, 179	26, 279	30, 358	53, 526	270, 428
Yule Gravel													60, 000
WHITE PINE DISTRICT.													
Original Hidden Treasure	9, 027	7, 549			5, 335	7, 322	9, 389	4, 410	1, 440		10, 194		54, 666
EUREKA DISTRICT.													
Eureka Consolidated	42, 040	39, 762	72, [illegible]	74, 670	53, 396	79, 230	192, 071	170, 785	130, 682	155, 134	99, 892	933	1, 110, 764
Phenix	1, 424	21, 044	4, 434	11, 133	1, 071		15, 266	15, 255		40, 608	28, 450	33, 774	172, 459
	1, 198, 637	1, 114, 858	1, 877, 245	1, 972, 438	1, 871, 448	1, 648, 035	1, 638, 600	1, 382, 689	1, 641, 138	1, 519, 164	1, 579, 132	1, 575, 064	19, 198, 736

Dividends for 1872.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
CALIFORNIA DISTRICT.													
Eureka	$20,000											$20,000	$40,000
Yule Gravel					$5,000								5,000
WASHOE.													
Belcher	104,000	$156,000	$156,000	$208,000	312,000	$312,000	$312,000	$312,000	$312,000				2,184,000
Chollar	28,000	28,000											56,000
Crown Point	120,000	180,000	180,000	300,000	480,000	300,000	300,000						1,860,000
ELY DISTRICT.													
Meadow Valley			90,000	90,000	60,000	60,000						60,000	360,000
Raymond & Ely	90,000	90,000	150,000	150,000	210,000	210,000	210,000	210,000	210,000	$210,000	$210,000	150,000	2,100,000
Total	362,000	454,000	576,000	748,000	1,067,000	882,000	822,000	522,000	522,000	210,000	210,000	230,000	6,605,000

Assessments for 1872.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Alamo											$7,500		$7,500
Arizona and Utah						$9,000		$18,000				$18,000	45,000
Baltimore								30,000					30,000
Baltimore American							$24,000						24,000
Baltimore Consolidated											27,000		27,000
Buckeye	$16,000		$20,000							$32,500			68,500
Bullion								37,500					37,500
Caledonia		$80,000							$40,000		60,000		180,000
Cook & Geyer									12,000				12,000
Consolidated Virginia			70,800						70,800			70,800	212,400
Daney		18,000		$36,000			18,000	24,000					96,000
Empire Mill	12,000						25,000						37,000
Exchequer						28,000							28,000
Globe									20,000				20,000
Gould & Curry	72,000			96,000				72,000		96,000			336,000
Hale & Norcross								80,000		80,000		80,000	240,000
Imperial	40,000									100,000			140,000

Julia				5,000							75,000		80,000
Justice					$21,000					42,000		21,000	84,000
Kentuck	20,000					20,000						20,000	60,000
Knickerbocker					24,000					24,000			48,000
New York Consolidated						18,000					9,000		27,000
Ophir				84,000			84,000			84,000			252,000
Overman	51,200		51,200			51,200				64,000			217,600
Pictou										3,750			3,750
Savage									160,000		160,000		320,000
Senator							6,000			12,000			18,000
Succor	34,200		45,600						22,800		22,800		125,400
Union Consolidated								10,000					10,000
Utah											20,000		20,000
ELY DISTRICT.													
Alps			22,500			15,000							37,500
Bowery							22,500		30,000				52,500
Chapman									15,000			7,500	22,500
Condor									25,000				25,000
Harper											3,000		3,000
Hermes											30,000		30,000
Huhn & Hunt			7,500		15,000			30,000			30,000		82,500
Ingomar				10,000		10,000		20,000					40,000
Kentucky										15,000			15,000
Louise									15,000				15,000
Marion												7,500	7,500
Mocking Bird												3,000	3,000
National							15,000						15,000
Newark						16,000			24,000				40,000
Orient											5,000		5,000
Page & Panaca				20,000				20,000					40,000
Peavine					7,500					7,500			15,000
Pioche											20,000		20,000
Pioche West Extension							10,500					8,750	19,250
Silver Peak												15,000	15,000
Washington & Creole		15,000			22,500				15,000		15,000		67,500
CALIFORNIA DISTRICT.													
Bellevue						10,000				15,000			25,000
El Dorado								3,000					3,000
Francis								12,000					12,000
Independent					12,500								12,500
Mount Jefferson	6,250												6,250
Peter Walter			8,000										8,000
Saint Patrick		20,000				15,000				10,000			45,000
Yule Gravel								2,500				2,000	4,500
IDAHO DISTRICT.													
Empire								12,500		50,000			62,500
Golden Chariot	25,000			15,000		25,000			10,000				75,000

Assessments for 1872—Continued.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
IDAHO DISTRICT—Continued.													
Ida Elmore			$30,000		$30,000								$60,000
Mahogany	$15,000			$15,000					$20,000				50,000
Minnesota					30,000				10,000		$10,000		50,000
South Chariot		$20,000							10,000		10,000		40,000
Virtue					20,000								20,000
War Eagle											20,000		20,000
WHITE PINE, EUREKA, AND OTHER DISTRICTS.													
Adams Hill					12,500								12,500
Columbus Mill and Mining												$37,500	37,500
General Lee				2,000						$2,000			4,000
Hidden Treasure Consolidated					1,200								1,200
Jackson				12,500									12,500
Mammoth						$3,600					3,600		7,200
McMahon												7,500	7,500
Noonday							$4,000			4,000			8,000
Original Hidden Treasure		31,999						$31,999		31,999			95,997
Phenix	37,500		37,500				50,000				25,000		150,000
Silver Wave	20,000			30,000					20,000				70,000
Star Consolidated						12,500					12,500		25,000
Ward Beecher											24,000		24,000
Total	349,150	184,999	293,100	325,500	196,200	233,300	259,000	403,499	519,600	673,749	589,400	298,550	4,326,047

Bullion receipts for 1873.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Belcher	$457,489	$730,014	$888,393	$1,184,475	$1,500,824	$914,592	$912,781	$601,759	$647,710	$831,263	$940,196	$1,099,674	$10,771,171
Buckeye	8,092	7,646	4,090	7,770	4,846	6,131	5,994	5,991	9,857	10,402	4,823	6,157	81,798
Crown Point	621,450	783,920	1,093,802	1,185,920	989,212	548,454	623,977	591,619	537,138	514,688	404,023	404,623	8,299,256
Chollar Potosi	40,679	53,797	50,788	60,699	28,769	17,025	46,449	64,479	43,636	42,902	42,270	72,855	573,348
Consolidated Virginia						5,970				124,906	246,722	273,660	651,258
Caledonia					18,959	18,905	21,637	24,453	26,776	20,576	11,760		142,366
Globe												1,145	1,145

Gould & Curry									10,063	25,134			35,197
Hale & Norcross	69,117	85,702	73,442	72,945	45,500	42,001	51,261	32,217	34,124	47,540	29,624	10,302	593,775
Imperial							8,343						8,343
Justice										4,762	9,109		13,871
Kentuck	15,014	7,176											22,190
Savage	44,036	17,925		13,169									75,130
Sierra Nevada	7,040		10,288	10,158	12,335	11,263	10,842	12,690	17,348	15,150	8,726	9,303	125,143
Silver Hill						19,392	18,045	14,506	10,874	6,125			68,942
Succor					5,999		3,535		612			9,770	19,916
Woodville					17,591	14,990			750	2,178	9,313	7,056	51,678
ELY DISTRICT.													
Amador Tunnel	16,158		11,276								4,192	4,192	35,818
Meadow Valley	62,344	23,410	54,013	47,503	57,407	141,219	86,710	63,398	52,020	56,471	52,900	41,251	738,646
Newark	2,236						18,977	27,842	55,678	23,595			128,328
Pioche				8,492		15,603		11,579	5,326	6,630	4,510	8,050	60,190
Raymond & Ely	274,775	226,860	284,161	248,226	239,025	204,808	143,259	204,450	167,011	130,690	114,378	160,751	2,398,394
Washington & Creole						31,905	31,905			9,627	10,058	33,192	116,687
IDAHO DISTRICT.													
Golden Chariot	6,550					94,759	72,727	74,690	51,791	25,414	65,100	63,435	444,475
Ida Elmore										3,323	2,405		5,728
Minnesota						47,644							47,644
Mahogany													15,216
CALIFORNIA DISTRICT.													
Cederberg	7,731	3,500	8,700			3,002	4,552	4,712	7,329		10,289		49,815
Chariot Mill	45,000											12,200	57,200
Consolidated Amador	46,081	45,302	26,018	18,427									135,828
Eureka, G. V.		19,412	45,811	31,882	33,525	36,937	40,995	35,306	41,967	27,928	25,993	33,822	373,578
WHITE PINE, PHILADELPHIA, AND EUREKA DISTRICTS.													
Columbus Mill and Mining Co.	15,063		9,829	10,197	9,471	8,718	8,278	7,629	5,401	2,569	4,033	6,261	87,449
El Dorado South							33,627	13,817	14,446	21,640	17,557		101,087
Eureka Consolidated	68,450			70,580	118,770	88,856	93,499	162,749	84,064	111,409	122,349	114,567	1,035,293
K K Consolidated						266,736						180,292	447,028
Monitor Belmont	56,979	22,065	43,865	10,575	2,683	12,688	6,293	26,697	16,664	11,647	1,007		221,163
Original Hidden Treasure										5,885			5,885
Ward Beecher							14,386	13,642	7,195	10,640	9,005		54,868
Total	1,843,293	2,026,629	2,603,476	2,961,008	3,086,086	2,474,988	2,258,072	2,084,925	1,885,010	2,093,094	2,151,541	2,554,558	28,085,247

Dividends disbursed by mines upon the board list for 1873.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
WASHOE.													
Belcher	$312,000	$312,000	$416,000	$520,000	$832,000	$1,040,000	$832,000	$728,000	$520,000	$312,000	$416,000	$520,000	$6,760,000
Crown Point		300,000	300,000	500,000	1,000,000	1,000,000	400,000	400,000	300,000	300,000	300,000	300,000	5,100,000
CALIFORNIA DISTRICT.													
Cederberg		12,000											12,000
Consolidated Amador	30,000	30,000	30,000	30,000							15,000	15,000	150,000
Eureka	20,000	20,000	40,000	40,000	40,000	20,000	20,000	20,000	20,000	40,000	20,000	20,000	320,000
EUREKA DISTRICT.													
Eureka Consolidated						50,000	50,000	50,000	50,000				200,000
K K Consolidated						12,500	12,500	12,500	12,500	12,500			62,500
ELY DISTRICT.													
Meadow Valley	60,000					60,000	60,000						180,000
Raymond & Ely	150,000	150,000							90,000				390,000
IDAHO DISTRICT.													
Golden Chariot								30,000	30,000	25,000			85,000
Minnesota								30,000	30,000				60,000
PHILADELPHIA DISTRICT.													
Monitor		25,000	25,000									25,000	75,000
Total	572,000	849,000	811,000	1,090,000	1,872,000	2,182,500	1,374,500	1,270,500	1,052,500	689,500	751,000	880,000	13,394,500

Assessments levied in the year 1873 upon the mines located on the Comstock Lode.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Alpha Consolidated											$18,000		$18,000
American Flat					$15,000		$15,000						30,000
Arizona and Utah		$18,000				$18,000			$9,000		9,000		54,000
Baltimore Consolidated			$40,500			40,500					54,000		135,000
Buckeye	$16,000						16,000					$16,000	48,000
Crown Point Ravine												15,000	15,000
Caledonia		40,000					40,000				60,000		140,000
Confidence			24,960										24,960

Consolidated Gold Hill Quartz								$15,000					15,000
Daney					12,000		6,000			$12,000			30,000
Dardanelles											60,000		60,000
Empire Mill	25,000			$25,000		50,000					50,000		150,000
Eclipse, Winters and Plato										12,500			12,500
"420"				4,500			3,750						8,250
Globe	20,000						15,000			10,000		10,000	55,000
Gould & Curry		48,000		48,000		48,000		48,000			72,000		264,000
Hale & Norcross							80,000			80,000			160,000
Imperial	100,000			100,000					100,000				300,000
Insurance					5,500				3,000				10,500
Jacob Little									37,200				37,200
Julia			45,000			15,000		22,500		30,000			112,500
Justice		31,500		21,000		21,000		21,000				52,500	147,000
Kentuck		30,000				45,000							75,000
Knickerbocker			24,000				24,000				36,000		84,000
Leo										3,200		8,000	11,200
Mint					5,000			5,000			5,000		15,000
New York Consolidated			18,000		18,000			9,000		9,000		18,000	72,000
Occidental		22,500											22,500
Ophir			84,000			84,000	50,400			84,000			302,400
Overman			64,000			51,200			76,800			76,800	268,800
Phil. Sheridan											12,000		12,000
Pictou		6,000				6,000				7,500			19,500
Rock Island						12,000							12,000
Savage	160,000			160,000			80,000		80,000			80,000	560,000
Senator		12,000				12,000					12,000		36,000
Silver Hill											108,000		108,000
Sierra Nevada											50,000		50,000
Succor								15,000				34,200	49,200
Trench										5,000			5,000
Tyler							8,750					9,900	18,650
Union Consolidated			5,000			5,000				10,000			20,000
Utah			20,000						20,000			20,000	60,000
Woodville			28,000				21,000		21,000		28,000		98,000
Yellow Jacket	120,000						120,000						240,000
Total	441,000	208,000	353,460	358,500	57,500	467,700	479,900	135,500	347,000	263,200	574,000	340,400	3,066,160

Assessments levied in the year 1873 upon the mines located in the Ely district.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Amador Tunnel						$30,000							$30,000
Arkansas	$15,000												15,000
American Flag						45,000			$30,000			$30,000	105,000
Alps		$15,000			$15,000			$15,000					45,000
Bowery					15,000						$15,000		30,000
Caroline					18,000				9,000		9,000		36,000
Charter Oak			$7,500				$7,500						15,000
Chapman			7,500				7,500						15,000
Chief of the Hill	15,000				15,000				15,000				45,000
Chief East Extension					7,200							3,600	10,800
Harper	3,000												3,000
Hermes					60,000								60,000
Huhn & Hunt		30,000			45,000			22,500				15,000	112,500
Ingomar				$10,000				10,000			10,000		30,000
Kentucky		30,000				45,000							75,000
Lillian Hall	3,750												3,750
Meadow Valley East	3,500												3,500
National								15,000					15,000
Newark	16,000			9,600								48,000	73,600
Orient						2,000							2,000
Page & Panaca		20,000						20,000					40,000
Peavine	7,500				7,500			7,500					22,500
Pioche		20,000						30,000		$20,000			70,000
Pioche Phenix					40,000								40,000
Pioche West Extension					17,500								17,500
Portland					7,500				7,500				15,000
Silver Peak				22,500					15,000				37,500
Silver West Consolidated						37,500							37,500
Standard					60,000								60,000
Spring Mount	8,750				17,500								26,250
Spring Mountain Tunnel			4,000			4,000							8,000
Washington & Creole				15,000			15,000			30,000			60,000
Total	72,500	115,000	19,000	57,100	323,200	163,500	30,000	120,000	76,500	50,000	34,000	96,600	1,159,400

Assessments levied upon mines located in outside districts during the year 1873.

Companies.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
CALIFORNIA DISTRICT.													
Alpine						$6,000							$6,000
Bellevue				$4,000							$10,000		14,000

Calaveras									$5,000				5,000
Independent				10,000					12,500				22,500
Saint Lawrence			$7,500					$10,000		$10,000		$2,500	30,000
Saint Patrick								10,000					10,000
Tecumseh		$7,500			$7,500			7,500	7,500	7,500			37,500
Yule Gravel						2,000							2,000
WHITE PINE DISTRICT.													
General Lee	$5,000												5,000
Hayes					10,000								10,000
McMahon	7,500	7,500				7,500			7,500			7,500	37,500
Mammoth			3,600				$3,600			3,600			10,800
Noonday					5,000						2,500		7,500
Original Hidden Treasure							21,333					21,333	42,666
Silver Wave									8,000				8,000
Ward Beecher								24,000				36,000	60,000
IDAHO DISTRICT.													
Empire	25,000			25,000			75,000			25,000			150,000
Golden Chariot	25,000		25,000		20,000								70,000
Ida Elmore	25,000		25,000				5,000			30,000			85,000
Mahogany			25,000			20,000						25,000	70,000
Red Jacket										20,000			20,000
Silver Cord									9,000				9,000
South Chariot		10,000			10,000		10,000				20,000		50,000
Virtue										15,000			15,000
War Eagle								25,000			15,000		40,000
EUREKA DISTRICT.													
Adams Hill									5,000				5,000
Columbus				25,000							25,000		50,000
Jackson			5,000			5,000							10,000
Phenix	25,000			12,500	12,500			12,500		25,000			87,500
Star Consolidated						5,000							5,000
MISCELLANEOUS DISTRICTS.													
Belmont								50,000		75,000			125,000
El Dorado South								60,000		60,000			120,000
Eye Patch											30,000		30,000
Juniata Consolidated	32,500												32,500
Wellington									12,500			25,000	37,500
Total	145,000	25,000	91,100	70,500	65,000	45,500	114,933	199,000	67,000	271,100	102,500	117,333	1,319,966

THE PRODUCT AND PRICE OF QUICKSILVER.

The preceding chapters of this report have furnished much information as to quicksilver. To this I add the following article from the Mining and Scientific Press of March 21, 1873, which I insert during the publication of this volume on account of the valuable detailed table of the product of the New Almaden Mine:

We have several times of late referred to the subject of the high prices of quicksilver, and the influence it has on the mining interests of the coast. We have endeavored also to explain to our readers that the popular idea that it is high because there is a "monopoly" is a fallacious one. We all know that there used to be a "monopoly," but it was broken up some time ago, or fell to pieces when there was no longer a necessity for one. The common laws of supply and demand regulated the matter in such a way that there was no necessity for the three mines forming the "monopoly" to keep up the combination. Moreover, there were so many new mines discovered last year, which produced all the way from fifty to six hundred flasks, that they could undersell the combination. These simple reasons, added to those that the supply was already decreasing and the demand increasing, were sufficient to make the combination of no earthly use. A high price was bound to ensue, and did ensue.

The protective tariff on quicksilver has for a long time operated against the mining interests. The Government never made anything by it, as we imported no quicksilver, and it could be bought in Europe, China, and Mexico much cheaper than in this State, where so much of it was produced. In the days of the monopoly, when the price was kept up by that combination, the supply exceeded the demand, and they sold their metal cheaper abroad than they would sell it here, which they could not have done if the tariff had been abolished. We notice that the California legislature has passed the bill asking Congress to abolish the tariff on this article; a move in the right direction, and one of benefit to the mining interests.

If our capitalists were not so apathetic, and had more confidence in cinnabar mines, a greater number of these mines would be opened. As the wants of the gold and silver mines are increasing from day to day, and from one to two pounds of quicksilver is lost to every ton of ore worked, there is no danger of want of a market for the metal. The only danger is that the supply will still decrease as the demands increase. New discoveries of this metal are made every few days, but very few of the mines are opened and worked systematically, for want of capital. Last week new mines of this character were discovered near Elk Horn Station, on the New Idria road, San Benito County, and advices from Mexico say that new quicksilver mines have been discovered in Zacatecas. Still, with all these new discoveries, the price does not come down. It is absurd to say that the "monopoly" controls all the capital in the State, or controls all these new mines. The price is high from natural causes, and not from the workings of any monopoly.

The New Almaden Mine is one of the richest in the world. It has a world-wide reputation, and is the representative mine of California. Its product has been greater than any other mine in America, and though much reduced, this mine still continues to yield more quicksilver than any other in the United States. It gives employment to about four hundred men, and has been systematically worked and developed. Through kindness of Mr. J. B. Randol, superintendent of the New Almaden, we are enabled to lay before our readers a statement of the quicksilver production of the mine for twenty-one years and three months. The mine was worked from 1846, up to 1850, in a limited way, but no record of the yield kept. From that date to the first of this year the mine has produced 573,150 flasks of quicksilver, containing 76½ pounds each.

The table appended to this article is a very complete one, and is the first detailed statement of the kind ever published. A simple statement of the product in flasks and pounds, with percentage of ore for seventeen and a half years, was completed and published in a book called the "Natural Wealth of California," in 1868, but it was incorrect, and, moreover, did not furnish any of the details we now give. In explanation of the table, it may be stated that the "grueso" or first-class ore is composed of the largest and richest pieces; the next lower or ordinary grade of ore is called "granza;" and the screenings and fine stuff is called "tierras." These "tierras" are made into "adobes" before being burnt. Under the heading of "flasks from the furnaces" is comprised all the mercury procured in the ordinary way by reduction. "Flasks from washings" indicates the amount of quicksilver obtained from under old furnaces, and about the works at different times, and from the leakage of imperfect furnaces. The amount obtained in this way is quite large. The other columns explain themselves. The mine has been run by the present company since the 1st of November, 1863.

The solution of this whole question of high price of quicksilver is seen under the heads of total flasks produced and percentage of ore. It will be seen that the product has steadily decreased of late years, as has the quality of the ore. In 1850 and 1851 the ore yielded 36.74 per cent. and in 1873 it yielded only 4.87 per cent. In 1867 the mine produced 47,194 flasks of quicksilver, and last year it produced 11,042 flasks. This mine, producing by far the greater proportion of quicksilver in the United States, and falling off in its product, while the demand has increased in even greater proportion than the supply has decreased, furnishes a solution of the whole question to any reasonable mind. Why quicksilver has varied in price is shown in those two columns of figures to which we refer.

Production of quicksilver at New Almaden, for twenty-one years and three months.

Date.	Class and quantity of ore.			Total.	Flasks from furnaces.	Flasks from washings.	Total.	Average amount per month.	Percentage, including all.	Percentage, (tierras.)	True percentage of ore, excluding tierras and washings.	Number of months.
	Grueso.	Granza.	Tierras.									
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*			*Flasks.*	*Flasks.*				
July, 1850, to June, 1851				4, 970, 717	23, 875		23, 875	1, 889¾	36. 74		36. 74	12
July, 1851, to June, 1852				4, 643, 290	19, 921		19, 921	1, 660	32. 82		32. 82	12
July, 1852, to June, 1853				4, 839, 520	18, 035		18, 035	1, 503	28. 50		28. 50	12
July, 1853, to June, 1854				7, 448, 000	26, 325		26, 325	2, 193¾	27. 03		27. 03	12
July, 1854, to June, 1855				9, 109, 300	31, 860		31, 860	2, 655	26. 75		26. 75	12
July, 1855, to June, 1856				10, 355, 200	28, 083		28, 083	2, 340¼	20. 74		20. 74	12
July, 1856, to June, 1857				10, 299, 000	26, 002		26, 002	2, 167	19. 31		19. 31	12
July, 1857, to June, 1858				10, 997, 170	29, 347		29, 347	2, 445½	20. 41		20. 41	12
July, 1858, to October, 1858				3, 873, 085	10, 588		10, 588	2, 647	20. 91		20. 91	4
November, 1858, to January, 1861*												
February, 1861, to January, 1862				13, 323, 200	32, 402	2, 363	34, 765	2, 897	19. 96		18. 64	12
February, 1862, to January, 1863				15, 281, 400	39, 262	1, 129	40, 391	3, 366	20. 22		19. 65	12
February, 1863, to August, 1863				7, 172, 660	17, 316	2, 248	19, 564	2, 795	20. 86		18. 46	7
September, 1863, to October, 1863				2, 346, 000	4, 820	700	5, 520	2, 760	18. 00		15. 67	2
November, 1863, to December, 1863	54, 800	1, 586, 500	718, 000	2, 359, 300	4, 040	407	4, 447	2, 223½	18. 65	3	17. 52	2
January, 1864, to December, 1864	1, 259, 400	18, 730, 300	3, 287, 900	23, 277, 600	42, 176	313	42, 489	3, 540¾	13. 96	3	15. 64	12
January, 1865, to December, 1865	2, 288, 900	25, 749, 000	3, 910, 500	31, 948, 400	47, 078	116	47, 194	3, 933	11. 30	3	12. 42	12
January, 1866, to December, 1866	1, 506, 000	19, 939, 100	5, 440, 200	26, 885, 300	34, 726	424	35, 150	2, 929	10. 00	3	11. 62	12
January, 1867, to December, 1867	731, 500	15, 689, 288	9, 603, 145	26, 023, 933	23, 990	471	24, 461	2, 038⅓	7. 19	3	9. 42	12
January, 1868, to December, 1868	2, 274, 208	14, 566, 600	12, 564, 722	29, 405, 530	25, 577	51	25, 628	2, 135⅙	6. 66	2	10. 12	12
January, 1869, to December, 1869	150, 000	11, 942, 175	13, 366, 000	25, 458, 175	16, 898		16, 898	1, 408	5. 07	2	8. 48	12
January, 1870, to December, 1870	30, 000	12, 531, 900	8, 535, 800	21, 097, 700	14, 423		14, 423	1, 202	5. 93	2	7. 42	12
January, 1871, to December, 1871		13, 661, 700	8, 373, 000	22, 034, 700	18, 563	5	18, 568	1, 547⅓	6. 44	2	9. 16	12
January, 1872, to December, 1872	142, 000	12, 777, 000	8, 497, 600	21, 416, 600	18, 391	183	18, 574	1, 548	6. 63	2	9. 57	12
January, 1873, to December, 1873		8, 492, 375	8, 838, 000	17, 330, 375	11, 042		11, 042	920	4. 87	2	7. 86	12
Total	8, 436, 808	155, 665, 938	83, 134, 867	351, 897, 055	564, 740	8, 410	573, 150	2, 247¾	12. 46	2½	15. 30	552
Product of Enriqueta from 1860 to 1863							10, 571					
Total product of all the mines on the company's property							†583, 721					

* Closed by injunction.

† Of 76½ pounds each, or 44,654,656½ pounds.

TOTAL PRODUCTION OF THE SILVER AND GOLD MINES OF AMERICA PRIOR TO THE DISCOVERY OF THE GOLD MINES OF CALIFORNIA.

[Quoted from Ure's Dictionary of Arts, Mines, etc., vol. ii, page 647, by Wheeler's San Francisco Weekly Stock Report, etc. Mr. Wheeler has changed the denominations employed by the editor of Ure, substituting pounds troy for kilograms, at the rate of 2⅝ pounds per kilogram, and dollars for francs, at the rate of 5 francs per dollar.]

Countries.	Silver.		Gold.		Total for each country.
	Weight.	Value.	Weight.	Value.	
	Pounds.		*Pounds.*		
United States			59,666	$14,440,000	$14,440,000
Mexico	165,294,724	$2,611,360,000	1,038,090	254,790,000	2,866,150,000
New Granada	692,730	11,020,000	1,511,328	370,880,000	381,900,000
Peru and Bolivia	156,707,314	2,481,210,000	907,714	222,680,000	2,703,890,000
Brazil			3,589,466	878,370,000	878,370,000
Chili	2,773,824	47,690,000	667,004	163,780,000	211,470,000
Total	325,466,592	5,151,280,000	7,773,268	1,904,940,000	7,056,220,000

BULLION PRODUCT OF THE UNITED STATES SINCE THE DISCOVERY OF GOLD IN CALIFORNIA.

The following estimates of the production of the United States in gold and silver since the discovery of gold in California are compiled from various sources. The aggregates are believed to be approximately correct.

Estimate of the gold product of the United States since 1847.

Year.	California.	Other States and Territories.	Total.
1848	$10,000,000		$10,000,000
1849	40,000,000		40,000,000
1850	50,000,000		50,000,000
1851	55,000,000		55,000,000
1852	60,000,000		60,000,000
1853	65,000,000		65,000,000
1854	60,000,000		60,000,000
1855	55,000,000		55,000,000
1856	55,000,000		55,000,000
1857	55,000,000		55,000,000
1858	50,000,000		50,000,000
1859	50,000,000		50,000,000
1860	45,000,000	$1,000,000	46,000,000
1861	40,000,000	3,000,000	43,000,000
1862	34,700,000	4,500,000	39,200,000
1863	30,000,000	10,000,000	40,000,000
1864	26,600,000	19,500,000	46,100,000
1865	28,500,000	24,725,000	53,225,000
1866	25,500,000	28,000,000	53,500,000
1867	25,000,000	26,725,000	51,725,000
1868	22,000,000	26,000,000	48,000,000
1869	22,500,000	27,000,000	49,500,000
1870	25,000,000	25,000,000	50,000,000
1871	20,000,000	23,500,000	43,500,000
1872	19,000,000	17,000,000	36,000,000
1873	17,000,000	19,000,000	36,000,000
	985,800,000	254,950,000	1,240,750,000

Estimate of the silver product of the United States since 1847.

From 1848 to 1858, inclusive, $50,000 per annum	$550,000
1859	100,000
1860	150,000
1861	2,000,000
1862	4,500,000
1863	8,500,000

1864	$11,000,000
1865	11,250,000
1866	10,000,000
1867	13,500,000
1868	12,000,000
1869	13,000,000
1870	16,000,000
1871	22,000,000
1872	25,750,000
1873	35,750,000
Total silver	186,050,000
Total gold	1,240,750,000
Total gold and silver from 1848 to 1873, inclusive	1,426,800,000
Gold product before 1848	14,440,000
Total gold and silver product of the United States	1,441,240,000

THE MINING INDUSTRY OF GREAT BRITAIN IN 1872.

[From the London Mining Journal, December 27, 1873.]

The total value of the metals produced, and of the coal and other minerals raised, during 1872 in the United Kingdom was £70,193,416, but it is explained that this increase of £12,871,523 is only apparent, being chiefly due to the additional price at which the value of coal at the pit's mouth has been estimated. As it is enacted by the coal and metalliferous mines regulation acts of 1872 that correct returns of the produce of every mine shall be made to the government inspector for the district in which it is situated, and as these local inspectors have necessarily facilities immensely greater than could possibly be possessed in a central office for verifying the returns and drawing correct conclusions from them, it may be anticipated that the statistics which will in future years be contained in the government inspectors' reports will be in every respect more accurate and reliable than any which it has hitherto been practicable to collect under the voluntary system. In the present return the estimate for copper ores is based chiefly upon the returns made to the stannary court, and upon the details of the public ticketings in Cornwall and at Swansea, and it is shown that nearly 92,000 tons of ore were raised, worth in round numbers £450,000. The production of copper-ore in the United Kingdom during 1873, as will be seen from our ticketing-table published in another column, has remained about stationary, so far as regards quantity, but in consequence of depression in the copper trade the smelters were enabled in the present year to purchase ore containing 8,411 tons fine copper for £600,000 instead of having to pay £6-3,000, as they had in the preceding year for 8,110 tons; the value of copper-ore has thus fallen about 12 per cent. But we are here giving figures which will only be officially published twelve months hence, and will therefore content ourselves with repeating the hope expressed last year, but, unfortunately, not realized, (for the statistics for 1872 are two months later than ever,) that under the new system the returns may be still more complete and yet more promptly obtained; and that, therefore, the publication of the mineral statistics of the United Kingdom may be effected at an earlier period of the year in future. Subjoined is the general summary for the two last years, in order that the movement of the several products may be compared.

General summary of minerals raised in 1872 *and* 1873.

Minerals.	Raised in 1871.		Raised in 1872.	
	Tons.	Value.	Tons.	Value.
Coal*	117,352,028	£35,205,608	123,497,316	£46,311,143
Iron-ore	16,334,880	7,670,572	16,584,857	7,774,874
Copper-ore	97,129	367,118	91,983	443,738
Tin-ore	16,272	1,030,834	14,366	1,246,135
Lead-ore	93,966	1,155,770	83,968	1,146,165
Zinc-ore	17,736	56,330	18,543	73,951
Iron pyrites, (sulphur-ore)	61,973	64,987	65,916	39,470
Silver-ore	5	421	....	....
Arsenic	4,148	15,519	5,172	17,964
Gossans, ochers, &c	697	1,396	3,327	8,227
Wolfram and tungstic soda	20	228	88	993
Manganese	5,548	22,958	7,773	38,865

General summary of minerals raised, &c.—Continued.

Minerals.	Raised in 1871.		Raised in 1872.	
	Tons.	Value.	Tons.	Value.
Nickel	2	£98	....	....
Bismuth	2 cwts.	14	2	....
Barytes	5, 512	3, 539	9, 093	£7, 078
Fluor-spar	51	26	81	48
Cobalt-ore	3	120	1	29
Chloride of barium	....	....	65	130
Clays, fine and fire, (estimated)	1, 255, 000	475, 000	1, 200, 000	450, 000
Earth minerals, various, (estimated)	....	600, 000	....	650, 000
Salt	1, 505, 725	752, 862	1, 309, 498	654, 748
Coprolites, (estimated)	36, 500	51, 000	35, 000	50, 000
Total value of minerals produced	....	47, 494, 400	....	58, 913, 541

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* In the evidence given before the select c[illegible]e of the House of Commons in 1873, on "the present dearness and scarcity of coal," it was sai[illegible] the rise in wages added 1*s.* 6*d.* to the cost of getting a ton of coal.

It will be seen that there was an increase both in the quantity and value of the zinc-ore raised as compared with the preceding year; but this improvement has not continued during 1873, if we may judge from complaints heard at meetings of mine companies that mines producing blende cannot, at present prices, be worked at a profit. Of iron pyrites a few thousand tons more were raised in 1872 than in the preceding year, and the price was about 50 per cent.; but in this case, also, the improvement has not continued. The yield of arsenic was 25 per cent. higher, but the price appears to have been somewhat lower. It was recently stated in the Mining Journal that the demand was very limited, the larger proportion being produced by the Devon Great Consols Company, and that a small increase in the supply would probably lead to a large decline in price. The variation in the yield of the other ores requires no special comment.

Metals obtained from the ores enumerated.

Metals.	1871.		1872.	
	Tons.	Value.	Tons.	Value.
Iron, pig	6, 627, 179	£16, 667, 947	6, 741, 929	£18, 540, 304
Tin	10, 900	1, 498, 750	9, 560	1, 450, 996
Copper	6, 280	475, 143	5, 703	583, 232
Lead	69, 056	1, 251, 815	60, 455	1, 209, 115
Zinc	4, 366	92, 743	5, 191	118, 076
Silver ......ounces	761, 490	190, 372	628, 920	157, 230
Other metals, (estimated)	....	3, 000	....	2, 500
Total value of metals	....	20, 179, 770	....	22, 070, 447

Absolute total value of the metals and coal, with other minerals which are not smelted, (except building-stones, lime, slates, and common clays,) produced in the United Kingdom.

Value of the metals produced	£20, 179, 770	£22, 070, 447
Value of the coal	35, 205, 608	46, 311, 143
Value of other minerals	1, 936, 515	1, 811, 826
Total value	57, 321, 893	70, 193, 416

Concerning the returns made under the mines regulation acts of 1872, colliery owners and mine adventurers may well be congratulated that the letter of the acts has been complied with as to the keeping secret of the returns confidentially made to the inspectors; even our esteemed correspondent, Mr. Robert Hunt, F. R. S., the keeper of mining records, has not been permitted to examine them. In his introduction to the statistics, with an early copy of which he has, as usual, favored us, he states that as respects coal, it has become a question, seeing how closely the progress of our manufacturing industries are connected with the production and cost of fuel, to determine for each year, with all possible accuracy, the rate of increase in the production of coal from the collieries of the United Kingdom. Up to 1871 voluntary returns formed the basis upon which the returns of coal given in the mineral statistics were computed, Circumstances beyond control in 1871 rendered it imperative to adopt instead the returns which had been made to the colliery inspectors, and these gave a rate of increase above that which was the rate in previous years. Again, for the year 1872, under the operation of the "coal mines regulation act, 1872," the returns made by the inspectors to the secretary of state for the home department are the sources from which the production of coal given in the following pages are drawn, and the only sources available. The operation of clause 38 of this act is to limit the examination of those returns to the inspectors and the secretary of state. Consequently the keeper of mining records has not been permitted to examine them, and he has no means of ascertaining whether or not errors have arisen in making those returns, or in the computation of the aggregates, when they are made. The only means by which he can this year check the returns as they are now given is by a cautious examination of the distribution of coal. In the present volume Mr. Hunt has given great attention to this portion of the subject, and in future journals it will be more fully referred to, as well as the details concerning the several minerals, &c., embraced in the return.

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